

Allen-Bradley 1336/1336VT 1336 PLUS/PLUS II/FORCE/IMPACT Chopper Module

Cat. Nos. 1336 -WA018, WB009 & WC009
 -WA070, WB035 & WC035
 -WA115, WB110 & WC085

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What This Option Provides

The brake chopper module is an open style assembly that together with customer supplied braking resistors can increase the braking torque capability of a 1336, 1336VT, 1336PLUS, 1336PLUSII, 1336FORCE or 1336IMPACT drive from approximately 10 to 100%.

Where This Option is Used

B003-B250 and C003-C250 1336 Drives.

B003-B250 1336VT Drives.

AQF05-A125, BRF05-B600 and CWF10-C600 1336PLUS and 1336PLUSII Drives.

A001-A125, B001-B600 and C001-C650 1336FORCE and 1336IMPACT Drives.

1336 — W T	B T	009 T
1336	Voltage Rating	Continuous Amp Rating
1336VT	A = 230VAC	018 = 375VDC, 18.0ADC
1336PLUS		070 = 375VDC, 70.0ADC
1336PLUS II		115 = 375VDC, 115.0ADC
1336FORCE	B = 380/415/460VAC	009 = 750VDC, 9.0ADC
Brake Chopper Module		035 = 750VDC, 35.0ADC
		110 = 750VDC, 110.0ADC
	C = 575VAC	009 = 935VDC, 9.0ADC
		035 = 935VDC, 35.0ADC
		085 = 935VDC, 85.0ADC

What These Instructions Contain

These instructions contain the necessary information to select, configure and install dynamic braking. By completing **Selecting a Chopper Module and the Maximum Dynamic Brake Resistance** first you will be able to determine:

1. Whether or not dynamic braking is required for your application.
2. If dynamic braking is required, the rating and quantity of chopper modules required as well as the size and type of braking resistors required.

How Dynamic Braking Works

When an induction motor's rotor is turning slower than the synchronous speed set by the drive's output power, the motor is transforming electrical energy obtained from the drive into mechanical energy available at the drive shaft of the motor. This process is referred to as *motoring*. When the rotor is turning faster than the synchronous speed set by the drive's output power, the motor is transforming mechanical energy available at the drive shaft of the motor into electrical energy that can be transferred back into the utility grid. This process is referred to as *regeneration*.

Most AC PWM drives convert AC power from the fixed frequency utility grid into DC power by means of a diode rectifier bridge or controlled SCR bridge before it is inverted into variable frequency AC power. Diode and SCR bridges are cost effective, but can only handle power in the motoring direction. Therefore, if the motor is regenerating, the bridge cannot conduct

the necessary negative DC current, the DC bus voltage will increase and cause a Bus Overvoltage trip at the drive.

Expensive bridge configurations use SCRs or transistors that can transform DC regenerative electrical energy into fixed frequency utility electrical energy. A more cost effective solution is to provide a Transistor Chopper on the DC Bus of the AC PWM drive that feeds a power resistor which transforms the regenerative electrical energy into thermal energy. This is generally referred to as Dynamic Braking.

How the Chopper Module Works

Figure 1 shows a simplified schematic of a Chopper Module with Dynamic Brake Resistor. The Chopper Module is shown connected to the positive and negative conductors of an AC PWM Drive. The two series connected Bus Caps are part of the DC Bus filter of the AC Drive.

A Chopper Module contains five significant power components:

Protective fuses are sized to work in conjunction with a **Crowbar SCR**. Sensing circuitry within the Chopper Transistor Voltage Control determines if an abnormal conditions exist within the Chopper Module, such as a shorted Chopper Transistor. When an abnormal condition is sensed, the Chopper Transistor Voltage Control will fire the Crowbar SCR, shorting the DC Bus, and melting the fuse links. This action isolates the Chopper Module from the DC Bus until the problem can be resolved.

The **Chopper Transistor** is an Insulated Gate Bipolar Transistor (IGBT). The Chopper Transistor is either ON or OFF, connecting the Dynamic Brake Resistor to the DC Bus and dissipating power, or isolating the resistor from the DC Bus. There are several transistor ratings that are used in the various Chopper Module ratings. The most important rating is the collector current rating of the Chopper Transistor that helps to determine the minimum ohmic value used for the Dynamic Brake Resistor.

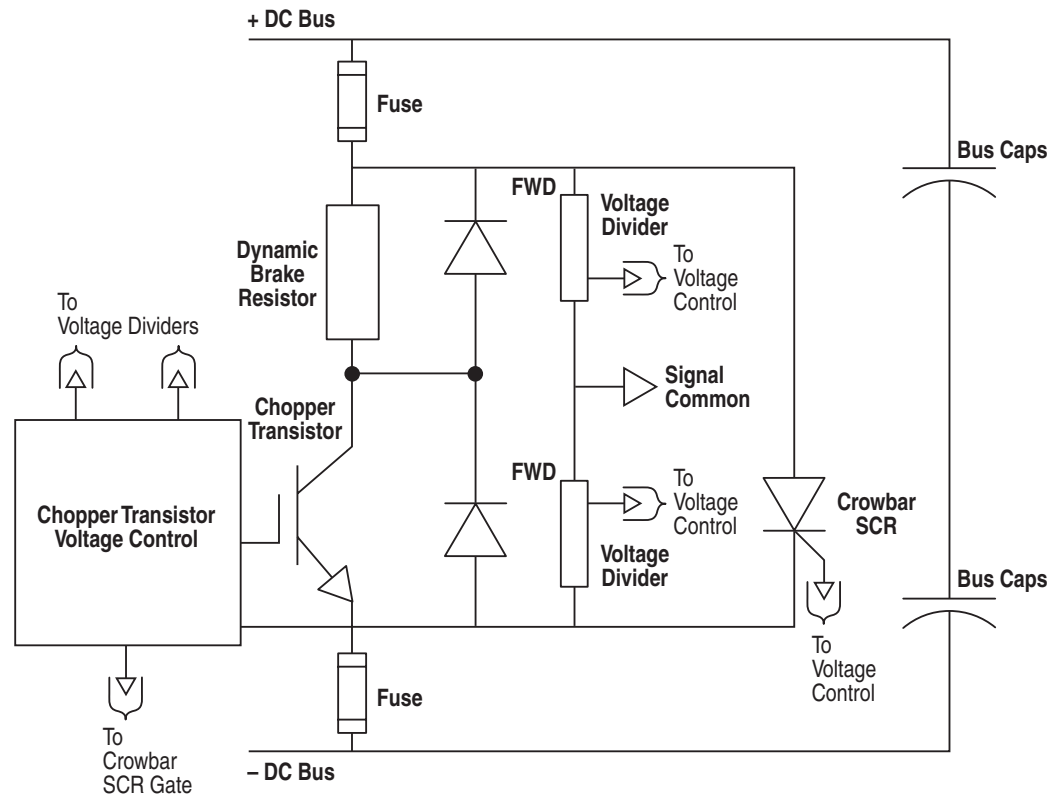
Chopper Transistor Voltage Control (hysteretic voltage comparator) regulates the voltage of the DC Bus during regeneration. The average values of DC Bus voltages are:

- 375V DC (for 230V AC input)
- 750V DC (for 460V AC input)
- 937.5V DC (for 575V AC input)

Voltage dividers reduce the DC Bus voltage to a value that is usable in signal circuit isolation and control. The DC Bus feedback voltage from the voltage dividers is compared to a reference voltage to actuate the Chopper Transistor.

The **Freewheel Diode** (FWD), in parallel with the Dynamic Brake Resistor, allows any magnetic energy stored in the parasitic inductance of that circuit to be safely dissipated during turn off of the Chopper Transistor.

Figure 1
Schematic of Chopper Module and Dynamic Brake Resistor



Chopper Modules are designed to be applied in parallel if the current rating is insufficient for the application. One Chopper Module is the designated Master Chopper Module, while any other Modules are the designated Follower Modules.

Two lights are provided on the front of the enclosure to indicate operation.

- **DC Power** light illuminates when DC power has been applied to the Chopper Module.
- **Brake On** light flickers when the Chopper Module is operating (*chopping*).

How to Select a Chopper Module and Dynamic Brake Resistor

As a rule, a Chopper Module can be specified when regenerative energy is dissipated on an occasional or periodic basis. In general, the motor power rating, speed, torque, and details regarding the regenerative mode of operation will be needed in order to estimate what Chopper Module rating and Dynamic Brake Resistor value to use. If a drive is consistently operating in the regenerative mode of operation, serious consideration should be given to equipment that will transform the electrical energy back to the fixed frequency utility.

In order to select the appropriate Chopper Module and Dynamic Brake Resistor for your application, the following data must be calculated.

Peak Regenerative Power of the Drive (Expressed in watts of power.)

This value is used to determine:

- The minimum current rating of the Chopper Module
Choose the actual current rating from the selection tables.
- The estimated maximum ohmic value of the Dynamic Brake Resistor
If this value is greater than the maximum imposed by the peak regenerative power of the drive, the drive can trip off due to transient DC Bus overvoltage problems.

Minimum Dynamic Brake Resistance

If a Dynamic Brake Resistance value that is less than the minimum imposed by the choice of the Chopper Module is applied, damage can occur to the Chopper Transistor.

Dynamic Brake Resistor's Allowable Ohmic Value Range

(Use the Chopper Module current rating to determine this range.)

These values range between the minimum value set by the Chopper Transistor current rating and the maximum value set by the peak regenerative power developed by the drive in order to decelerate or satisfy other regenerative applications.

Wattage Rating of the Dynamic Brake Resistor

This rating is estimated by applying what is known about the drive's motoring and regenerating modes of operation. The average power dissipation of the regenerative mode must be estimated and the wattage of the Dynamic Brake Resistor chosen to be greater than the average regenerative power dissipation of the drive.

Dynamic Brake Resistors with large thermodynamic heat capacities, defined as thermal time constants less than 5 seconds, are able to absorb a large amount of energy without the temperature of the resistor element exceeding the operational temperature rating. Thermal time constants in the order of 50 seconds and higher satisfy the criteria of large heat capacities for these applications. If a resistor has a small heat capacity, the temperature of the resistor element could exceed maximum temperature limits during the application of pulse power to the element.

Selecting a Chopper Module and the Maximum Dynamic Brake Resistance

The following calculations are demonstrated using The International System of Units (SI).

Gather the following information:

- Power rating from motor nameplate in watts, kilowatts, or horsepower
- Speed rating from motor nameplate in rpm or rps (radians per second)
- Motor inertia and load inertia in kg-m² or lb-ft²
- Gear ratio (GR) if a gear is present between the motor and load
- Motor shaft speed, torque, and power profile of the drive application

Figure 2 shows the speed, torque, and power profiles of the drive as a function of time for a particular cyclic application that is periodic over t_4 seconds. The desired time to decelerate is known or calculable and is within the drive performance limits. In **Figure 2**, the following variables are defined:

$\omega(t)$ = Motor shaft speed in radians per second (**rps**)

$$\omega \times \frac{\text{Rad}}{\text{s}} = \frac{2\pi N}{60}$$

$N(t)$ = Motor shaft speed in Revolutions Per Minute (**RPM**)

$T(t)$ = Motor shaft torque in Newton-meters

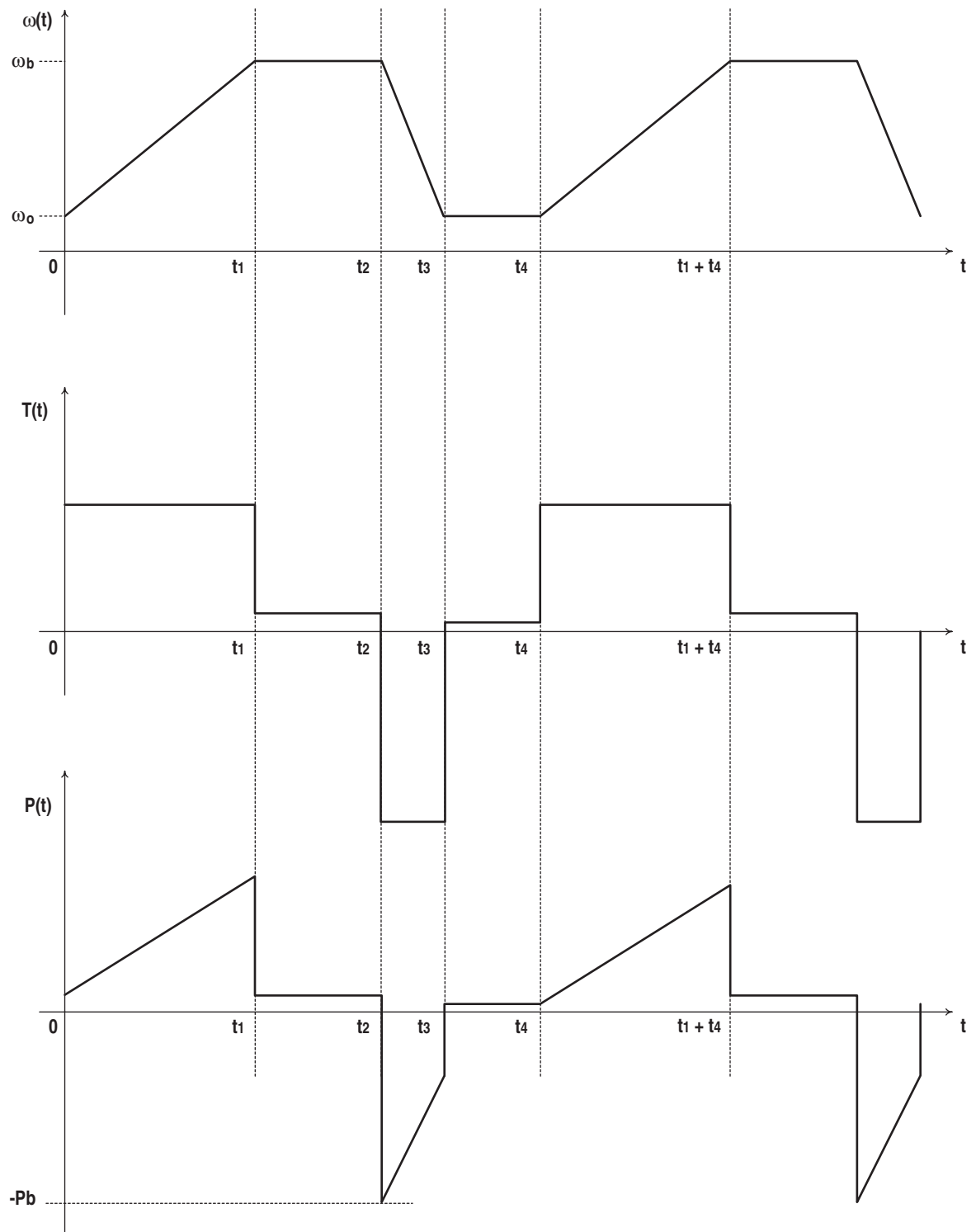
$$1.0 \text{ lb-ft} = 1.355818 \text{ N-m}$$

$P(t)$ = Motor shaft power in watts

$$1.0 \text{ HP} = 746 \text{ watts}$$

-P_b = Motor shaft peak regenerative power in watts

Figure 2
Application Speed, Torque and Power Profiles



Step 1 — Determine Gear Ratio

$$GR = \frac{\text{Turns of Load}}{\text{Turns of Motor}}$$

$$GR = \underline{\hspace{2cm}}$$

Step 2 — Determine the Total Inertia

$$J_T = J_m + GR^2 \times J_L \quad J_T = \text{Total inertia reflected to the motor shaft (kg-m}^2 \text{ or lb-ft}^2\text{)}$$

$$J_m = \text{Motor inertia (kg-m}^2 \text{ or lb-ft}^2\text{)}$$

$$GR = \text{Gear ratio of any gear between motor and load (dimensionless)}$$

$$J_L = \text{Load inertia (kg-m}^2 \text{ or lb-ft}^2\text{)}$$

$$1.0 \text{ lb-ft}^2 = 0.04214011 \text{ kg-m}^2$$

$$J_T = [\quad + \quad] \times [\quad] \quad J_T = \underline{\hspace{2cm}} \text{ kg-m}^2 \text{ or lb-ft}^2$$

Step 3 — Calculate the Peak Braking Power

$$P_b = \frac{J_T \times \omega_b (\omega_b - \omega_o)}{(t_3 - t_2)}$$

$$J_T = \text{Total inertia reflected to the motor shaft (kg-m}^2\text{)}$$

$$\omega_b = \text{Rated angular rotational speed (Rad / s = } 2\pi N_b / 60\text{)}$$

$$\omega_o = \text{Angular rotational speed, less than rated speed down to zero (Rad / s)}$$

$$N_b = \text{Rated motor speed (RPM)}$$

$$t_3 - t_2 = \text{Deceleration time from } \omega_b \text{ to } \omega_o \text{ (seconds)}$$

$$P_b = \text{Peak braking power (watts)}$$

$$1.0 \text{ HP} = 746 \text{ watts}$$

$$P_b = \frac{[\quad \times \quad (\quad - \quad)]}{[\quad - \quad]} \quad P_b = \underline{\hspace{2cm}} \text{ watts}$$

Compare the peak braking power to that of the rated motor power. If the peak braking power is greater than 1.5 times that of the motor, then the deceleration time ($t_3 - t_2$) needs to be increased so that the drive does not go into current limit.

Step 4 — Calculate the Maximum Dynamic Brake Resistance Value

$R_{db1} = \frac{V_d^2}{P_b}$	R_{db1} = Maximum allowable value for the dynamic brake resistor (ohms) V_d = DC Bus voltage the chopper module regulates to (375V DC, 750V DC, or 937.5V DC) P_b = Peak braking power calculated in Step 2 (watts)
$R_{db1} = \frac{[\quad \times \quad]}{[\quad]}$	$R_{db1} = \text{_____ ohms}$

The choice of the Dynamic Brake resistance value should be less than the value calculated in **Step 4**. If the resistance value is greater than the value calculated in **Step 4**, the drive can trip on DC Bus overvoltage.

Step 5 — Calculate the Minimum Chopper Module Current Rating

$I_{d1} = \frac{V_d}{R_{db1}}$	I_{d1} = Minimum current flow through Chopper Transistor V_d = Value of DC Bus voltage chosen in Step 3 R_{db1} = Value of Dynamic Brake Resistor calculated in Step 3
$I_{d1} = \frac{[\quad]}{[\quad]}$	$I_{d1} = \text{_____ amps}$

The value of I_{d1} sets the minimum current rating for the Chopper Module. When choosing a Chopper Module, the current rating for the Chopper Transistor must be greater than or equal to the value calculated for I_{d1} .

Step 6 — Calculate the Minimum Dynamic Brake Resistor Value

$R_{db2} = \frac{V_d}{0.75 \times I_{d2}}$	R_{db2} = Minimum ohmic value of the Dynamic Brake Resistor V_d = Value of DC Bus voltage chosen in Step 3 I_{d2} = Value of Chopper Module current rating
$R_{db2} = \frac{[\quad]}{[\quad]}$	$R_{db2} = \text{_____ ohms}$

This step calculates the minimum resistance value that the Dynamic Brake Resistor can have. If a lower resistance were to be used with the Chopper Module of choice, the IGBT could be damaged from overcurrent.

Step 7 — Choose the Dynamic Brake Resistance Value

Use to Table 1a, 2a, or 3a to choose the correct table based on the Chopper Module's regulating voltage.

1. Find the column that lists the value of Dynamic Brake Resistance for the various Dynamic Brake Resistor assemblies.
2. Choose the resistor value that lies between R_{db1} and R_{db2} .
Preferred resistance values are as close R_{db1} as possible.

Step 8 — Estimate the Minimum Wattage Requirements for the Dynamic Brake Resistor

It is assumed that the application exhibits a periodic function of acceleration and deceleration. If $(t_3 - t_2)$ equals the time in seconds necessary for deceleration from rated speed to 0 speed, and t_4 is the time in seconds before the process repeats itself, then the average duty cycle is $(t_3 - t_2)/t_4$. The power as a function of time is a linearly decreasing function from a value equal to the peak regenerative power to 0 after $(t_3 - t_2)$ seconds have elapsed. The average power regenerated over the interval of $(t_3 - t_2)$ seconds is $P_b/2$. The average power in watts regenerated over the period t_4 is:

$$P_{av} = \frac{[t_3 - t_2]}{t_4} \times \frac{P_b}{2} \left(\frac{\omega_b + \omega_o}{\omega_b} \right)$$

P_{av} = Average dynamic brake resistor dissipation (watts)

$t_3 - t_2$ = Deceleration time from ω_b to ω_o (seconds)

t_4 = Total cycle time or period of process (seconds)

P_b = Peak braking power (watts)

ω_b = Rated motor speed (Rad / s)

ω_o = A lower motor speed (Rad / s)

$$P_{av} = \left[\frac{\quad - \quad}{\quad} \right] \times \left[\frac{\quad}{2} \right] \quad P_{av} = \quad \text{watts}$$

The Dynamic Brake Resistor power rating, in watts, that is chosen should be equal to or greater than the value calculated in **Step 8**.

Example Calculation**Application Information**

A 100 HP, 460 Volt motor and drive is accelerating and decelerating as depicted in **Figure 2**.

- Cycle period (t_4) is 60 seconds
- Rated speed is 1785 RPM
- Deceleration time from rated speed to 0 speed is 6.0 seconds
- Motor load can be considered purely as an inertia
- All power expended or absorbed by the motor is absorbed by the motor and load inertia
- Load inertia is directly coupled to the motor
- Motor inertia plus load inertia is given as 9.61 kg-m²

Calculate Application Values

Use the Application Information to calculate the necessary values to choose an acceptable Chopper Module and Dynamic Brake Resistor.

$$\text{Rated Power of Motor} = 100 \text{ HP} \times 746 = 74.6 \text{ kW}$$

This information is given and must be known before the calculation process begins. If this rating is given in horsepower, convert to watts before using in the equations.

$$\text{Rated Speed} = 1785 \text{ RPM} = 2\pi \times 1785/60 = 186.93 \text{ Rad/s} = \omega$$

This information is given and must be known before the calculation process begins. If this rating is given in RPM, convert to radians per second before using in the equations.

$$\text{Total Inertia} = 9.61 \text{ kg-m}^2 = J_T$$

If this value is given in lb-ft² or Wk², convert to kg-m² before using in the equations. Total inertia is given and does not need further calculations as outlined in **Step 2**.

$$\text{Deceleration Time} = 6.0 \text{ seconds} = (t_3 - t_2)$$

$$\text{Period of Cycle} = 60 \text{ seconds} = t_4$$

$$\text{DC Bus Voltage} = 750 \text{ Volts} = V_d$$

This is known because the drive is rated at 460 Volts rms.

If a drive is rated 230 Volts rms, $V_d = 375 \text{ Volts}$.

If a drive is rated 575 Volts rms, $V_d = 937.5 \text{ Volts}$.

Select the Correct Chopper Module

$$\text{Peak Braking Power} = J_T \omega^2 / (t_3 - t_2) = 55.96 \text{ kW} = P_b$$

This is 75% rated power and is less than the maximum drive limit of 150% current limit. This calculation is the result of **Step 3** and determines the peak power that must be dissipated by the Dynamic Brake Resistor.

$$\text{Maximum Dynamic Brake Resistance} = V_d^2 / P_b = 10.5 \text{ ohms} = R_{db1}$$

This calculation is the result of **Step 4** and determines the maximum ohmic value of the Dynamic Brake Resistor. Note that a choice of $V_d = 750 \text{ Volts}$ DC was made based on the premise that the drive is rated at 460 Volts.

$$\text{Minimum Current Flow} = V_d / R_{db1} = 74.62 \text{ amps} = I_{d1}$$

This calculation is the result of **Step 5**. This is the minimum value of current that will flow through the Dynamic Brake Resistor when the Chopper Module Transistor is turned on. Refer to Table 2b in the Installation Instructions for the Brake Chopper Module, Publication 1336-5.65. Choose the Brake Chopper Module whose peak current capacity is greater than 74.62 amps. The correct choice must be the WB035 Chopper Module because it has a current rating greater than 74.62 amps.

$$\text{Minimum Dynamic Brake Resistance} = V_d/I_{d2} = 10 \text{ ohms} = R_{db2}$$

This is the result of **Step 6** and is also included as a value in Table 2b.

Choose the 10.4 ohms resistor, type T10F4R2K97, rated at 2.97 kW from Table 2a.

$$\text{Average Power Dissipation} = [(t_3 - t_2)/t_4]P_b/2 = 2.8 \text{ kW} = P_{av}$$

This is the result of calculating the average power dissipation as outlined in **Step 8**. Verify that the power rating of the Dynamic Brake Resistor chosen in **Step 7** is greater than the value calculated in **Step 8**. Note that the actual resistor wattage rating is much greater than what is needed. The type T10F4R2K97 assembly is the best choice based on resistance and wattage values.

Ordering Resistors

Resistor assemblies listed are manufactured by IPC Power Resistors International Incorporated and Powerohm Resistors Incorporated and have been tested with Allen-Bradley Chopper Modules.

Available resistor assembly options include an overtemperature switch (see Wiring Schemes), auxiliary terminal blocks and custom enclosures.

For purchase information, contact:

IPC Power Resistors International Inc.
167 Gap Way
Erlanger, KY 41018
Tel. 859-282-2900 Fax. (859) 282-2904
www.ipcresistors.com

Powerohm Resistors Inc.
5713 13th Street
Katy, TX 77493
Tel. 800-838-4694 Fax. (859) 384-8099
www.powerohm.com

Chopper Module Selection

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
956	242	552-1	4225	IPC
956	400	555-1A	6260	IPC
956	597	550-1A	6260	IPC
956	605	555-1	6260	IPC
956	915	550-1	6260	IPC
695	248	552-2A	4929	IPC
695	333	552-2	4929	IPC
695	553	555-2A	7981	IPC
695	825	550-2A	7981	IPC
695	832	555-2	7981	IPC
695	1258	550-2	15258	IPC
615	180	442-1A	4225	IPC
615	242	442-1	4225	IPC
615	404	445-1A	4225	IPC
615	602	440-1A	13302	IPC
615	605	445-1	13615	IPC
615	915	440-1	13302	IPC
546	316	552-3A	5634	IPC
546	424	552-3	12050	IPC
546	707	555-3A	12050	IPC
546	1055	550-3A	23004	IPC
546	1059	555-3	23004	IPC
546	1601	550-3	36619	IPC
439	254	442-2A	2973	IPC
439	339	442-2	2973	IPC
439	568	445-2A	2973	IPC
439	847	445-2	11267	IPC
439	848	440-2A	9389	IPC
439	1281	440-2	24647	IPC
364	477	552-4A	3990	IPC
364	635	552-4	15336	IPC
364	1065	555-4A	24412	IPC
364	1588	555-4	38496	IPC
364	1590	550-4A	38496	IPC
364	2402	550-4	39514	IPC
342	329	442-3A	3677	IPC
342	435	442-3	3677	IPC
342	734	445-3A	14397	IPC
342	1088	445-3	23473	IPC
342	1096	440-3A	22534	IPC
342	1645	440-3	36306	IPC
283	614	552-5A	19092	IPC
283	817	552-5	19092	IPC
283	1372	555-5A	30046	IPC
283	2043	555-5	48120	IPC
283	2048	550-5A	47338	IPC
283	3089	550-5	76680	IPC
237	473	442-4A	5321	IPC
237	628	442-4	15649	IPC
237	1057	445-4A	25351	IPC
237	1570	445-4	38496	IPC
237	1577	440-4A	39748	IPC
237	2373	440-4	61422	IPC
196	890	552-6A	20970	IPC
196	1180	552-6	33567	IPC
196	1987	555-6A	53519	IPC
196	2950	555-6	83096	IPC
196	2965	550-6A	83096	IPC
196	4460	550-6	130669	IPC
181	620	442-5A	19248	IPC
181	822	442-5	19248	IPC
181	1385	445-5A	30985	IPC
181	2055	445-5	77853	IPC
181	2068	440-5A	77853	IPC
181	3108	440-5	77775	IPC

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
154	182	222-1A	6416	IPC
154	242	222-1	6416	IPC
154	408	225-1A	6416	IPC
154	604	225-1	16431	IPC
154	610	220-1A	16431	IPC
154	913	220-1	16431	IPC
150	400	PF150R400W	7700	Powerohm
150	800	PF150R800W	12100	Powerohm
150	1200	PF150R1K20	30000	Powerohm
150	1600	PF150R1K60	54200	Powerohm
150	2000	PF150R2K00	53500	Powerohm
150	2400	PF150R2K40	82500	Powerohm
150	2800	PF150R2K80	132000	Powerohm
150	3200	PF150R3K20	136500	Powerohm
150	3600	PF150R3K60	196200	Powerohm
150	4000	PF150R4K00	192400	Powerohm
150	5200	PF150R5K20	333400	Powerohm
150	5600	PF150R5K60	329100	Powerohm
128	874	442-6A	22065	IPC
128	1162	442-6	32863	IPC
128	1951	445-6A	55397	IPC
128	2906	445-6	86382	IPC
128	2912	440-6A	82626	IPC
128	4395	440-6	138024	IPC
125	400	PF125R400W	6500	Powerohm
125	800	PF125R800W	18300	Powerohm
125	1200	PF125R1K20	25200	Powerohm
125	1386	552-7A	32863	IPC
125	1600	PF125R1K60	44200	Powerohm
125	1850	552-7	51954	IPC
125	2000	PF125R2K00	68700	Powerohm
125	3095	555-7A	130903	IPC
125	3600	PF125R3K60	161600	Powerohm
125	4000	PF125R4K00	277800	Powerohm
125	4620	550-7A	208131	IPC
125	4625	555-7	208131	IPC
125	6994	550-7	212513	IPC
125	7200	PF125R7K20	341300	Powerohm
125	7600	PF125R7K60	344600	Powerohm
117	300	T117R300W	7950	IPC
117	600	T117R600W	10100	IPC
117	900	T117R900W	10600	IPC
117	1200	T117R1K2	12500	IPC
117	1500	T117R1K5	15800	IPC
117	2100	T117R2K1	18600	IPC
117	2700	T117R2K7	14300	IPC
117	3000	T117R3K0	20800	IPC
110	255	222-2A	7511	IPC
110	338	222-2	7511	IPC
110	570	225-2A	18779	IPC
110	845	225-2	18779	IPC
110	850	220-2A	18779	IPC
110	1278	220-2	46947	IPC
100	400	PF100R400W	5200	Powerohm
100	800	PF100R800W	20000	Powerohm
100	1200	PF100R1K20	35300	Powerohm
100	1600	PF100R1K60	55000	Powerohm
100	2000	PF100R2K00	89800	Powerohm
100	2400	PF100R2K40	130800	Powerohm
100	2800	PF100R2K80	125700	Powerohm
100	3600	PF100R3K60	211600	Powerohm
100	4000	PF100R4K00	205200	Powerohm
100	4800	PF100R4K80	285500	Powerohm
100	5200	PF100R5K20	275000	Powerohm
100	5600	PF100R5K60	273100	Powerohm

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
100	6800	PF100R6K80	450100	Powerohm
100	8000	PF100R8K00	692400	Powerohm
100	9200	PF100R9K20	676300	Powerohm
97	300	T97R300W	10300	IPC
97	600	T97R600W	13400	IPC
97	900	T97R900W	13800	IPC
97	1200	T97R1K2	16500	IPC
97	1500	T97R1K5	20800	IPC
97	2100	T97R2K1	15400	IPC
97	2700	T97R2K7	19100	IPC
97	3000	T97R3K0	16800	IPC
97	3600	T97R3K6	22400	IPC
97	4200	T97R4K2	19100	IPC
85	326	222-3A	9076	IPC
85	400	PF85R400W	6900	Powerohm
85	438	222-3	9076	IPC
85	730	225-3A	23004	IPC
85	800	PF85R800W	17200	Powerohm
85	1089	220-3A	36384	IPC
85	1094	225-3	36384	IPC
85	1200	PF85R1K20	46200	Powerohm
85	1600	PF85R1K60	75400	Powerohm
85	1654	220-3	57901	IPC
85	2000	PF85R2K00	109000	Powerohm
85	2056	552-8A	57588	IPC
85	2720	552-8	92016	IPC
85	2800	PF85R2K80	179500	Powerohm
85	3600	PF85R3K60	173600	Powerohm
85	4592	555-8A	233795	IPC
85	5200	PF85R5K20	379200	Powerohm
85	5600	PF85R5K60	383300	Powerohm
85	6800	PF85R6K80	588500	Powerohm
85	6801	555-8	231135	IPC
85	6854	550-8A	231135	IPC
85	7200	PF85R7K20	578500	Powerohm
85	10000	PF85R10K0	934100	Powerohm
85	10285	550-8	361490	IPC
85	11200	PF85R11K2	923100	Powerohm
81	1389	442-7A	34975	IPC
81	1837	442-7	55084	IPC
81	3102	445-7A	55319	IPC
81	4592	445-7	224640	IPC
81	4629	440-7A	221432	IPC
81	6944	440-7	221276	IPC
80	300	T80R300W	8530	IPC
80	400	PF80R400W	6500	Powerohm
80	600	T80R600W	10900	IPC
80	800	PF80R800W	16000	Powerohm
80	900	T80R900W	18500	IPC
80	1200	T80R1K2	13700	IPC
80	1200	PF80R1K20	44600	Powerohm
80	1500	T80R1K5	17500	IPC
80	2000	PF80R2K00	102600	Powerohm
80	2100	T80R2K1	19100	IPC
80	2700	T80R2K7	24600	IPC
80	3000	T80R3K0	22100	IPC
80	3600	T80R3K6	18500	IPC
80	4000	PF80R4K00	229300	Powerohm
80	4200	T80R4K2	25100	IPC
80	4500	T80R4K5	23300	IPC
80	5700	T80R5K7	29400	IPC
80	7600	PF80R7K60	545700	Powerohm
80	8000	PF80R8K00	897500	Powerohm
80	9000	T80R9K0	209000	IPC
80	9300	T80R9K3	230000	IPC
77	300	T77R300W	8210	IPC
77	600	T77R600W	10600	IPC

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
77	900	T77R900W	17900	IPC
77	1200	T77R1K2	20800	IPC
77	1500	T77R1K5	16400	IPC
77	2100	T77R2K1	19100	IPC
77	2700	T77R2K7	23800	IPC
77	3000	T77R3K0	21300	IPC
77	3600	T77R3K6	28100	IPC
77	4200	T77R4K2	24200	IPC
77	4500	T77R4K5	22400	IPC
77	5700	T77R5K7	28700	IPC
77	9000	T77R9K0	209000	IPC
77	9300	T77R9K3	230000	IPC
70	400	PF70R400W	5700	Powerohm
70	800	PF70R800W	25000	Powerohm
70	1200	PF70R1K20	62000	Powerohm
70	2400	PF70R2K40	153900	Powerohm
70	2527	552-9A	76680	IPC
70	3303	552-9	144048	IPC
70	4800	PF70R4K80	308300	Powerohm
70	5643	555-9A	189665	IPC
70	8258	555-9	297173	IPC
70	8424	550-9A	295765	IPC
70	9600	PF70R9K60	1249300	Powerohm
70	12489	550-9	482144	IPC
65	400	PF65R400W	9500	Powerohm
65	800	PF65R800W	23600	Powerohm
65	1200	PF65R1K20	59300	Powerohm
65	2000	PF65R2K00	138900	Powerohm
65	2400	PF65R2K40	141100	Powerohm
65	3600	PF65R3K60	178100	Powerohm
65	4000	PF65R4K00	291700	Powerohm
65	7200	PF65R7K20	712100	Powerohm
65	7600	PF65R7K60	709900	Powerohm
65	16640	PF65R16K6	690800	Powerohm
60	300	T60R300W	10300	IPC
60	400	PF60R400W	8700	Powerohm
60	600	T60R600W	13000	IPC
60	800	PF60R800W	21400	Powerohm
60	900	T60R900W	13700	IPC
60	1200	T60R1K2	16400	IPC
60	1500	T60R1K5	20800	IPC
60	2000	PF60R2K00	128300	Powerohm
60	2700	T60R2K7	18500	IPC
60	3600	T60R3K6	22000	IPC
60	4000	PF60R4K00	269300	Powerohm
60	4500	T60R4K5	28000	IPC
60	6900	T60R6K9	164000	IPC
60	8000	PF60R8K00	659400	Powerohm
60	11000	T60R11K0	448000	IPC
60	15896	PF60R15K8	690800	Powerohm
59	473	222-4A	10094	IPC
59	631	222-4	25038	IPC
59	1056	225-4A	39201	IPC
59	1576	225-4	64161	IPC
59	1577	220-4A	64161	IPC
59	2384	220-4	99762	IPC
56	2010	442-8A	61344	IPC
56	2657	442-8	154455	IPC
56	4490	445-8A	245062	IPC
56	6642	445-8	245375	IPC
56	6702	440-8A	245375	IPC
56	10045	440-8	388094	IPC
55	400	PF55R400W	8000	Powerohm
55	800	PF55R800W	30800	Powerohm
52	400	PF52R400W	10400	Powerohm
52	800	PF52R800W	28600	Powerohm
52	1200	PF52R1K20	65400	Powerohm

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
52	1600	PF52R1K60	111200	Powerohm
52	2400	PF52R2K40	149600	Powerohm
52	2800	PF52R2K80	142400	Powerohm
52	3200	PF52R3K20	233400	Powerohm
52	4800	PF52R4K80	352900	Powerohm
52	5600	PF52R5K60	569300	Powerohm
52	6000	PF52R6K00	577000	Powerohm
52	9600	PF52R9K60	598400	Powerohm
52	13312	PF52R13K3	621800	Powerohm
52	18625	PF52R18K6	583500	Powerohm
48	300	T48R300W	13100	IPC
48	400	PF48R400W	9600	Powerohm
48	600	T48R600W	16500	IPC
48	800	PF48R800W	26400	Powerohm
48	900	T48R900W	17500	IPC
48	1200	T48R1K2	20800	IPC
48	1200	PF48R1K20	61600	Powerohm
48	1500	T48R1K5	16600	IPC
48	2000	PF48R2K00	98500	Powerohm
48	2700	T48R2K7	23300	IPC
48	3000	T48R3K0	21100	IPC
48	3600	T48R3K6	28000	IPC
48	3600	PF48R3K60	86200	Powerohm
48	4200	T48R4K2	23800	IPC
48	5670	T48R5K67	131000	IPC
48	6600	T48R6K6	131000	IPC
48	12600	T48R12K6	359000	IPC
48	19100	T48R19K1	656000	IPC
48	20400	T48R20K4	716000	IPC
45	300	T45R300W	12300	IPC
45	600	T45R600W	15800	IPC
45	617	222-5A	30828	IPC
45	827	222-5	30828	IPC
45	1200	T45R1K2	19100	IPC
45	1378	225-5A	49529	IPC
45	1500	T45R1K5	24900	IPC
45	2056	220-5A	124800	IPC
45	2066	225-5	124800	IPC
45	2100	T45R2K1	28100	IPC
45	2700	T45R2K7	22000	IPC
45	3000	T45R3K0	19800	IPC
45	3125	220-5	197177	IPC
45	3600	T45R3K6	26600	IPC
45	3883	552-10A	120810	IPC
45	5138	552-10	308128	IPC
45	6000	T45R6K0	125000	IPC
45	8672	555-10A	370410	IPC
45	12600	T45R12K6	359000	IPC
45	12846	555-10	409420	IPC
45	12943	550-10A	409420	IPC
45	19100	T45R19K1	656000	IPC
45	19427	550-10	563362	IPC
44	400	PF44R400W	8800	Powerohm
44	800	PF44R800W	39500	Powerohm
44	1200	PF44R1K20	57700	Powerohm
44	2000	PF44R2K00	126100	Powerohm
44	2561	442-9A	121670	IPC
44	2800	PF44R2K80	197900	Powerohm
44	3381	442-9	190604	IPC
44	3600	PF44R3K60	79000	Powerohm
44	4000	PF44R4K00	300900	Powerohm
44	5600	PF44R5K60	477000	Powerohm
44	5720	445-9A	184031	IPC
44	7200	PF44R7K20	793400	Powerohm
44	7600	PF44R7K60	775400	Powerohm
44	8454	445-9	305624	IPC
44	8537	440-9A	302807	IPC

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
44	11264	PF44R11K2	483600	Powerohm
44	12784	440-9	369388	IPC
44	15000	PF44R15K0	495000	Powerohm
44	23276	PF44R23K2	1263600	Powerohm
40	300	T40R300W	10900	IPC
40	400	PF40R400W	8000	Powerohm
40	800	PF40R800W	35900	Powerohm
40	900	T40R900W	14300	IPC
40	1200	T40R1K2	17300	IPC
40	1200	PF40R1K20	83400	Powerohm
40	1800	T40R1K8	18500	IPC
40	2000	PF40R2K00	114700	Powerohm
40	3200	PF40R3K20	277000	Powerohm
40	4000	T40R4K0	105000	IPC
40	4000	PF40R4K00	448800	Powerohm
40	6000	PF40R6K00	727000	Powerohm
40	10000	T40R10K0	309000	IPC
40	10240	PF40R10K2	414500	Powerohm
40	11000	T40R11K0	333000	IPC
40	11429	PF40R11K4	440000	Powerohm
40	16000	T40R16K0	521000	IPC
40	16000	PF40R16K0	638700	Powerohm
40	17000	T40R17K0	574000	IPC
40	19000	T40R19K0	568000	IPC
40	22000	T40R22K0	1202000	IPC
40	22858	PF40R22K8	1130600	Powerohm
36	400	PF36R400W	12900	Powerohm
36	800	PF36R800W	32400	Powerohm
36	1200	PF36R1K20	77000	Powerohm
36	1600	PF36R1K60	103200	Powerohm
36	2000	PF36R2K00	99000	Powerohm
36	2400	PF36R2K40	79200	Powerohm
36	4000	PF36R4K00	395700	Powerohm
36	4400	PF36R4K40	399000	Powerohm
36	9216	PF36R9K21	414500	Powerohm
36	11298	555-11A	316618	IPC
36	16517	555-11	449907	IPC
36	16863	550-11A	449907	IPC
36	19044	PF36R19K0	1064100	Powerohm
36	24978	550-11	1321116	IPC
35	5058	552-11A	157272	IPC
35	6423	552-11	249757	IPC
34	300	T34R300W	14700	IPC
34	900	T34R900W	19100	IPC
34	1800	T34R1K8	25100	IPC
34	2400	T34R2K4	30100	IPC
34	3600	T34R3K6	93000	IPC
34	4000	T34R4K0	98600	IPC
34	8000	T34R8K0	262000	IPC
34	9000	T34R9K0	285000	IPC
34	13000	T34R13K0	456000	IPC
34	15000	T34R15K0	456000	IPC
34	17000	T34R17K0	990000	IPC
34	18000	T34R18K0	1017000	IPC
34	19000	T34R19K0	1048000	IPC
34	26000	T34R26K0	1591000	IPC
32	300	T32R300W	13800	IPC
32	400	PF32R400W	11400	Powerohm
32	600	T32R600W	17500	IPC
32	800	PF32R800W	41100	Powerohm
32	875	222-6A	35054	IPC
32	900	T32R900W	19100	IPC
32	1162	222-6	55162	IPC
32	1200	PF32R1K20	70600	Powerohm
32	1500	T32R1K5	28100	IPC
32	1600	PF32R1K60	91800	Powerohm
32	1955	225-6A	88573	IPC

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
32	2000	PF32R2K00	143600	Powerohm
32	2100	T32R2K1	20200	IPC
32	2400	PF32R2K40	113100	Powerohm
32	2700	T32R2K7	25200	IPC
32	2800	PF32R2K80	220200	Powerohm
32	2906	225-6	82626	IPC
32	2918	220-6A	82626	IPC
32	3600	PF32R3K60	102600	Powerohm
32	4000	T32R4K0	83300	IPC
32	4395	220-6	222215	IPC
32	4500	T32R4K5	105000	IPC
32	4800	PF32R4K80	581600	Powerohm
32	5200	PF32R5K20	583400	Powerohm
32	8420	T32R8K42	246000	IPC
32	9144	PF32R9K14	345400	Powerohm
32	10368	PF32R10K3	385000	Powerohm
32	12700	T32R12K7	410000	IPC
32	13545	PF32R13K5	511000	Powerohm
32	17100	T32R17K1	931000	IPC
32	18000	T32R18K0	1017000	IPC
32	18286	PF32R18K2	931100	Powerohm
32	21632	PF32R21K6	1203600	Powerohm
32	26000	T32R26K0	1591000	IPC
32	27090	PF32R27K0	2541900	Powerohm
32	28000	T32R28K0	2304000	IPC
29	3800	442-10A	127069	IPC
29	5130	442-10	199993	IPC
29	8487	445-10A	253840	IPC
29	12667	440-10A	359925	IPC
29	12826	445-10	359925	IPC
29	19396	440-10	615920	IPC
28	400	PF28R400W	15400	Powerohm
28	800	PF28R800W	35900	Powerohm
28	1200	PF28R1K20	57300	Powerohm
28	1600	PF28R1K60	77000	Powerohm
28	2000	PF28R2K00	124100	Powerohm
28	2800	PF28R2K80	314200	Powerohm
28	4000	PF28R4K00	502600	Powerohm
28	4400	PF28R4K40	493600	Powerohm
28	5600	PF28R5K60	320400	Powerohm
28	6096	552-12A	299521	IPC
28	7501	PF28R7K50	345400	Powerohm
28	8258	552-12	237463	IPC
28	9072	PF28R9K07	330000	Powerohm
28	11200	PF28R11K2	447100	Powerohm
28	13615	555-12A	359925	IPC
28	15001	PF28R15K0	846300	Powerohm
28	18928	PF28R18K9	1132800	Powerohm
28	20321	550-12A	1100930	IPC
28	20646	555-12	1033301	IPC
28	23548	PF28R23K5	2224200	Powerohm
28	30001	PF28R30K0	3042600	Powerohm
28	30492	550-12	2138364	IPC
28	36288	PF28R36K2	4610000	Powerohm
27	300	T27R300W	18500	IPC
27	600	T27R600W	15400	IPC
27	900	T27R900W	24900	IPC
27	1200	T27R1K2	18800	IPC
27	1500	T27R1K5	23700	IPC
27	2100	T27R2K1	27300	IPC
27	3300	T27R3K3	73900	IPC
27	8420	T27R8K42	358000	IPC
27	11500	T27R11K5	391000	IPC
27	15000	T27R15K0	931000	IPC
27	21600	T27R21K6	1346000	IPC
27	27400	T27R27K4	2075000	IPC
25	300	T25R300W	17200	IPC

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
25	400	PF25R400W	13800	Powerohm
25	600	T25R600W	14300	IPC
25	800	PF25R800W	55600	Powerohm
25	900	T25R900W	23000	IPC
25	1200	T25R1K2	27700	IPC
25	1200	PF25R1K20	71400	Powerohm
25	1500	T25R1K5	22000	IPC
25	1600	PF25R1K60	55000	Powerohm
25	2000	PF25R2K00	173100	Powerohm
25	2400	PF25R2K40	130800	Powerohm
25	2800	PF25R2K80	277000	Powerohm
25	3200	PF25R3K20	272600	Powerohm
25	3300	T25R3K3	73900	IPC
25	3900	T25R3K9	190000	IPC
25	6876	PF25R6K87	276400	Powerohm
25	8420	T25R8K42	328000	IPC
25	10158	PF25R10K1	383200	Powerohm
25	13751	PF25R13K7	752200	Powerohm
25	21025	PF25R21K0	2012300	Powerohm
25	25600	PF25R25K6	2789000	Powerohm
25	32400	PF25R32K4	4149000	Powerohm
25	40632	PF25R40K6	1445600	Powerohm
25	55001	PF25R55K0	2926300	Powerohm
24	7340	552-13A	211079	IPC
24	9635	552-13	299938	IPC
24	16393	555-13A	533797	IPC
24	24086	555-13	1173670	IPC
24	24468	550-13A	1871068	IPC
24	36710	550-13	844315	IPC
23	300	T23R300W	15800	IPC
23	600	T23R600W	20800	IPC
23	800	PF23R800W	51300	Powerohm
23	900	T23R900W	21300	IPC
23	1200	PF23R1K20	63500	Powerohm
23	1500	T23R1K5	20200	IPC
23	1600	PF23R1K60	82600	Powerohm
23	2000	PF23R2K00	157300	Powerohm
23	2100	T23R2K1	23100	IPC
23	3600	PF23R3K60	185800	Powerohm
23	4982	442-11A	254295	IPC
23	6310	T23R6K31	179000	IPC
23	6469	442-11	399830	IPC
23	7452	PF23R7K45	275000	Powerohm
23	7490	T23R7K49	328000	IPC
23	10200	T23R10K2	310000	IPC
23	11125	445-11A	492736	IPC
23	15548	PF23R15K5	900900	Powerohm
23	16172	445-11	825698	IPC
23	29808	PF23R29K8	3841600	Powerohm
21	400	PF21R400W	18900	Powerohm
21	800	PF21R800W	47100	Powerohm
21	1200	PF21R1K20	57700	Powerohm
21	1600	PF21R1K60	75400	Powerohm
21	2000	PF21R2K00	143600	Powerohm
21	2400	PF21R2K40	107700	Powerohm
21	3200	PF21R3K20	373400	Powerohm
21	4000	PF21R4K00	240800	Powerohm
21	5626	PF21R5K62	236100	Powerohm
21	7426	PF21R7K42	234800	Powerohm
21	8400	PF21R8K40	319400	Powerohm
21	11251	PF21R11K2	564200	Powerohm
21	17661	PF21R17K6	1694600	Powerohm
21	22501	PF21R22K5	2282000	Powerohm
21	33600	PF21R33K6	5992900	Powerohm
21	45001	PF21R45K0	2394200	Powerohm
21	70644	PF21R70K6	6778300	Powerohm
20	300	T20R300W	13700	IPC

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
20	600	T20R600W	17300	IPC
20	900	T20R900W	18500	IPC
20	1372	222-7A	87086	IPC
20	1500	T20R1K5	28000	IPC
20	1860	222-7	55084	IPC
20	3063	225-7A	138493	IPC
20	4572	220-7A	222215	IPC
20	4650	225-7	221432	IPC
20	5940	T20R5K94	260000	IPC
20	7031	220-7	169227	IPC
20	8920	T20R8K92	267000	IPC
20	10700	T20R10K7	582000	IPC
20	15200	T20R15K2	924000	IPC
20	16605	440-11A	825698	IPC
20	20600	T20R20K6	1602000	IPC
20	24910	440-11	1781970	IPC
20	28400	T20R28K4	1066000	IPC
20	34600	T20R34K6	1148000	IPC
19	400	PF19R400W	17100	Powerohm
19	800	PF19R800W	39000	Powerohm
19	1200	PF19R1K20	84900	Powerohm
19	1600	PF19R1K60	68300	Powerohm
19	2000	PF19R2K00	213200	Powerohm
19	2800	PF19R2K80	339300	Powerohm
19	3200	PF19R3K20	344700	Powerohm
19	4864	PF19R4K86	207300	Powerohm
19	6716	PF19R6K71	220000	Powerohm
19	8213	PF19R8K21	272600	Powerohm
19	9540	552-14A	410613	IPC
19	10051	PF19R10K0	564200	Powerohm
19	12170	552-14	410613	IPC
19	13613	PF19R13K6	700700	Powerohm
19	16425	PF19R16K4	1497400	Powerohm
19	19456	PF19R19K4	2155200	Powerohm
19	21305	555-14A	1514674	IPC
19	30400	PF19R30K4	5393600	Powerohm
19	31798	550-14A	3029900	IPC
19	31965	555-14	2913365	IPC
19	40204	PF19R40K2	2128200	Powerohm
19	47709	550-14	5953399	IPC
19	63916	PF19R63K9	6142800	Powerohm
19	77824	PF19R77K8	8113500	Powerohm
18	6184	442-12A	152850	IPC
18	8266	442-12	234734	IPC
18	13810	445-12A	660558	IPC
18	20612	440-12A	1336477	IPC
18	20664	445-12	1336477	IPC
18	30910	440-12	899814	IPC
15.4	800	PF15F4R800W	42400	Powerohm
15.4	1200	PF15F4R1K20	106000	Powerohm
15.4	2400	PF15F4R2K40	123100	Powerohm
15.4	5063	PF15F4R5K06	165000	Powerohm
15.4	10410	PF15F4R10K4	600600	Powerohm
15.4	20251	PF15F4R20K2	2612300	Powerohm
15.4	41642	PF15F4R41K6	2407200	Powerohm
15	300	T15R300W	16400	IPC
15	600	T15R600W	20800	IPC
15	900	T15R900W	22000	IPC
15	1500	T15R1K5	38800	IPC
15	4210	T15R4K21	143000	IPC
15	6160	T15R6K16	232000	IPC
15	7132	442-13A	179963	IPC
15	8570	T15R8K57	466000	IPC
15	9919	442-13	328491	IPC
15	11400	T15R11K4	734000	IPC
15	12112	552-15A	550465	IPC
15	15927	445-13A	1158280	IPC

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
15	18173	552-15	1158280	IPC
15	23772	440-13A	719851	IPC
15	23894	445-13	719851	IPC
15	27060	555-15A	719851	IPC
15	35663	440-13	1313963	IPC
15	40388	550-15A	1300276	IPC
15	40587	555-15	1313963	IPC
15	60579	550-15	7591398	IPC
14	300	T14R300W	15400	IPC
14	600	T14R600W	19400	IPC
14	900	T14R900W	20700	IPC
14	1200	T14R1K2	24500	IPC
14	1800	T14R1K8	27800	IPC
14	2012	222-8A	61344	IPC
14	2657	222-8	154455	IPC
14	4495	225-8A	117367	IPC
14	6160	T14R6K16	232000	IPC
14	6642	225-8	172138	IPC
14	6708	220-8A	172138	IPC
14	10045	220-8	523728	IPC
14	11400	T14R11K4	734000	IPC
14	12700	T14R12K7	1038000	IPC
13	800	PF13R800W	58400	Powerohm
13	1600	PF13R1K60	111200	Powerohm
13	2800	PF13R2K80	238800	Powerohm
13	5457	PF13R5K45	191600	Powerohm
13	11000	PF13R11K0	1048200	Powerohm
12	9641	442-14A	440372	IPC
12	12398	442-14	890985	IPC
12	13780	552-16A	890985	IPC
12	20673	552-16	599876	IPC
12	21531	445-14A	1924486	IPC
12	30776	555-16A	1040221	IPC
12	32136	440-14A	1040221	IPC
12	32297	445-14	1040221	IPC
12	45934	550-16A	2387466	IPC
12	46170	555-16	2247026	IPC
12	48204	440-14	1314510	IPC
12	68911	550-16	10015318	IPC
11.5	400	PF11F5R400W	25700	Powerohm
11.5	800	PF11F5R800W	41300	Powerohm
11.5	1600	PF11F5R1K60	102600	Powerohm
11.5	2000	PF11F5R2K00	206500	Powerohm
11.5	2944	PF11F5R2K94	146900	Powerohm
11.5	3726	PF11F5R3K72	140900	Powerohm
11.5	4600	PF11F5R4K60	191600	Powerohm
11.5	6083	PF11F5R6K08	321100	Powerohm
11.5	7774	PF11F5R7K77	500500	Powerohm
11.5	9671	PF11F5R9K67	898500	Powerohm
11.5	11776	PF11F5R11K7	1254700	Powerohm
11.5	14904	PF11F5R14K9	1955300	Powerohm
11.5	18400	PF11F5R18K4	3196300	Powerohm
11.5	24334	PF11F5R24K3	1330100	Powerohm
11.5	31096	PF11F5R31K0	1840800	Powerohm
11.5	59616	PF11F5R59K6	7683200	Powerohm
11.5	110001	PF11F5R110K0	11663100	Powerohm
11	2561	222-9A	121123	IPC
11	3381	222-9	100080	IPC
11	5720	225-9A	237243	IPC
11	8454	225-9	407344	IPC
11	8537	220-9A	407344	IPC
11	12784	220-9	890985	IPC
10.4	300	T10F4R300W	17300	IPC
10.4	600	T10F4R600W	22900	IPC
10.4	900	T10F4R900W	24500	IPC
10.4	1500	T10F4R1K5	25400	IPC
10.4	2970	T10F4R2K97	95100	IPC

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
10.4	5360	T10F4R5K36	329000	IPC
10.4	6040	T10F4R6K4	489000	IPC
10.4	8890	T10F4R8K89	801000	IPC
10.4	11000	T10F4R11K0	359000	IPC
10.4	15500	T10F4R15K5	1742000	IPC
10.4	18900	T10F4R18K9	1991000	IPC
10.4	26000	T10F4R26K0	2002000	IPC
10.4	35600	T10F4R35K6	1230000	IPC
10.4	43900	T10F4R43K9	1367000	IPC
10.4	72300	T10F4R72K3	4620000	IPC
10.1	400	PF10F1R400W	20600	Powerohm
10.1	800	PF10F1R800W	35900	Powerohm
10.1	1200	PF10F1R1K20	112100	Powerohm
10	17713	552-17A	479901	IPC
10	26569	552-17	903350	IPC
10	39559	555-17A	1956117	IPC
10	59043	550-17A	1950414	IPC
10	59339	555-17	1950414	IPC
9.5	11926	442-15A	316618	IPC
9.5	17890	442-15	479901	IPC
9.5	26636	445-15A	3000513	IPC
9.5	39755	440-15A	2851152	IPC
9.5	39955	445-15	1079776	IPC
9.5	59635	440-15	1820386	IPC
9.2	400	PF9F2R400W	18900	Powerohm
9.2	800	PF9F2R800W	32400	Powerohm
9.2	1200	PF9F2R1K20	102200	Powerohm
9.2	1600	PF9F2R1K60	75500	Powerohm
9.2	2000	PF9F2R2K00	161600	Powerohm
9.2	2355	PF9F2R2K35	98000	Powerohm
9.2	2981	PF9F2R2K98	116700	Powerohm
9.2	3751	PF9F2R3K75	135600	Powerohm
9.2	4867	PF9F2R4K86	282100	Powerohm
9.2	6601	PF9F2R6K60	341800	Powerohm
9.2	7737	PF9F2R7K73	748700	Powerohm
9.2	9421	PF9F2R9K42	1075400	Powerohm
9.2	11923	PF9F2R11K9	1520800	Powerohm
9.2	15001	PF9F2R15K0	545200	Powerohm
9.2	19467	PF9F2R19K4	1064100	Powerohm
9.2	24876	PF9F2R24K8	1416000	Powerohm
9.2	30948	PF9F2R30K9	2965500	Powerohm
9.2	37683	PF9F2R37K6	4056800	Powerohm
9.2	47693	PF9F2R47K6	6146600	Powerohm
9.2	58880	PF9F2R58K8	10387700	Powerohm
9.2	69635	PF9F2R69K6	6672400	Powerohm
9.2	90001	PF9F2R90K0	9127700	Powerohm
9.2	132480	PF9F2R132K2	23372300	Powerohm
8	14093	442-16A	401656	IPC
8	21143	442-16	693480	IPC
8	23427	552-18A	1211023	IPC
8	31474	445-16A	1564893	IPC
8	35138	552-18	2494758	IPC
8	46977	440-16A	2966898	IPC
8	47219	445-16	1560331	IPC
8	52321	555-18A	1559677	IPC
8	70477	440-16	3325398	IPC
8	78475	555-18	5345909	IPC
7.3	3826	222-10A	164245	IPC
7.3	5095	222-10	267369	IPC
7.3	8545	225-10A	566990	IPC
7.3	12738	225-10	359925	IPC
7.3	12754	220-10A	359925	IPC
7.3	19264	220-10	656981	IPC
7	400	PF7R400W	19300	Powerohm
7	800	PF7R800W	35900	Powerohm
7	1200	PF7R1K20	123900	Powerohm
7	1600	PF7R1K60	77000	Powerohm

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
7	2268	PF7R2K26	77800	Powerohm
7	2800	PF7R2K80	107500	Powerohm
7	3703	PF7R3K70	199600	Powerohm
7	4732	PF7R4K73	300300	Powerohm
7	6240	PF7R6K23	599000	Powerohm
7	7383	PF7R7K38	765100	Powerohm
7	9307	PF7R9K30	1303500	Powerohm
7	11251	PF7R11K2	436200	Powerohm
7	14812	PF7R14K8	802700	Powerohm
7	18928	PF7R18K9	1132800	Powerohm
7	23548	PF7R23K5	2330100	Powerohm
7	28672	PF7R28K6	3042600	Powerohm
7	36912	PF7R36K9	4610000	Powerohm
7	45001	PF7R45K0	7990600	Powerohm
7	55001	PF7R55K0	5083700	Powerohm
7	64512	PF7R64K5	6845800	Powerohm
7	81648	PF7R81K6	10141900	Powerohm
7	110001	PF7R110K0	17978700	Powerohm
7	127575	PF7R127K7	21021300	Powerohm
7	157500	PF7R157K7	34493700	Powerohm
6.5	2106	PF6F5R2K10	92600	Powerohm
6.5	2600	PF6F5R2K60	90400	Powerohm
6.5	3438	PF6F5R3K43	188100	Powerohm
6.5	4394	PF6F5R4K39	256400	Powerohm
6.5	5466	PF6F5R5K46	599000	Powerohm
6.5	6656	PF6F5R6K65	717000	Powerohm
6.5	8424	PF6F5R8K42	1086300	Powerohm
6.4	17529	442-17A	574859	IPC
6.4	26292	442-17	719851	IPC
6.4	39148	445-17A	1231840	IPC
6.4	58430	440-17A	4818224	IPC
6.4	58718	445-17	4929414	IPC
6	28008	552-19A	1960167	IPC
6	42015	552-19	1981674	IPC
6	62551	555-19A	2135190	IPC
5.7	4938	222-11A	260816	IPC
5.7	6525	222-11	421193	IPC
5.7	11029	225-11A	905640	IPC
5.7	16314	225-11	880744	IPC
5.7	16461	220-11A	880744	IPC
5.7	24694	220-11	1781970	IPC
5.4	1670	T5F4R1K67	55700	IPC
5.4	2680	T5F4R2K68	185000	IPC
5.4	5080	T5F4R5K8	401000	IPC
5.4	5780	T5F4R5K78	169000	IPC
5.4	7280	T5F4R7K28	328000	IPC
5.4	12000	T5F4R12K0	699000	IPC
5.4	20300	T5F4R20K3	738000	IPC
5.4	22000	T5F4R22K0	717000	IPC
5.4	37700	T5F4R37K7	2310000	IPC
5.4	48100	T5F4R48K1	1845000	IPC
5.4	51900	T5F4R51K9	1953000	IPC
5.4	104000	T5F4R104K0	3444000	IPC
5.1	400	PF5F1R400W	35400	Powerohm
5.1	800	PF5F1R800W	41100	Powerohm
5.1	1600	PF5F1R1K60	141300	Powerohm
5.1	2704	PF5F1R2K70	158300	Powerohm
5.1	3448	PF5F1R3K44	212400	Powerohm
5.1	4290	PF5F1R4K29	449300	Powerohm
5.1	5408	PF5F1R5K40	537700	Powerohm
5.1	6610	PF5F1R6K60	869000	Powerohm
5.1	8160	PF5F1R8K16	1412200	Powerohm
5.1	10791	PF5F1R10K7	564200	Powerohm
5.1	13790	PF5F1R13K7	800800	Powerohm
5.1	17156	PF5F1R17K1	1694600	Powerohm
5.1	27501	PF5F1R27K5	3380700	Powerohm
5.1	32640	PF5F1R32K6	5992900	Powerohm

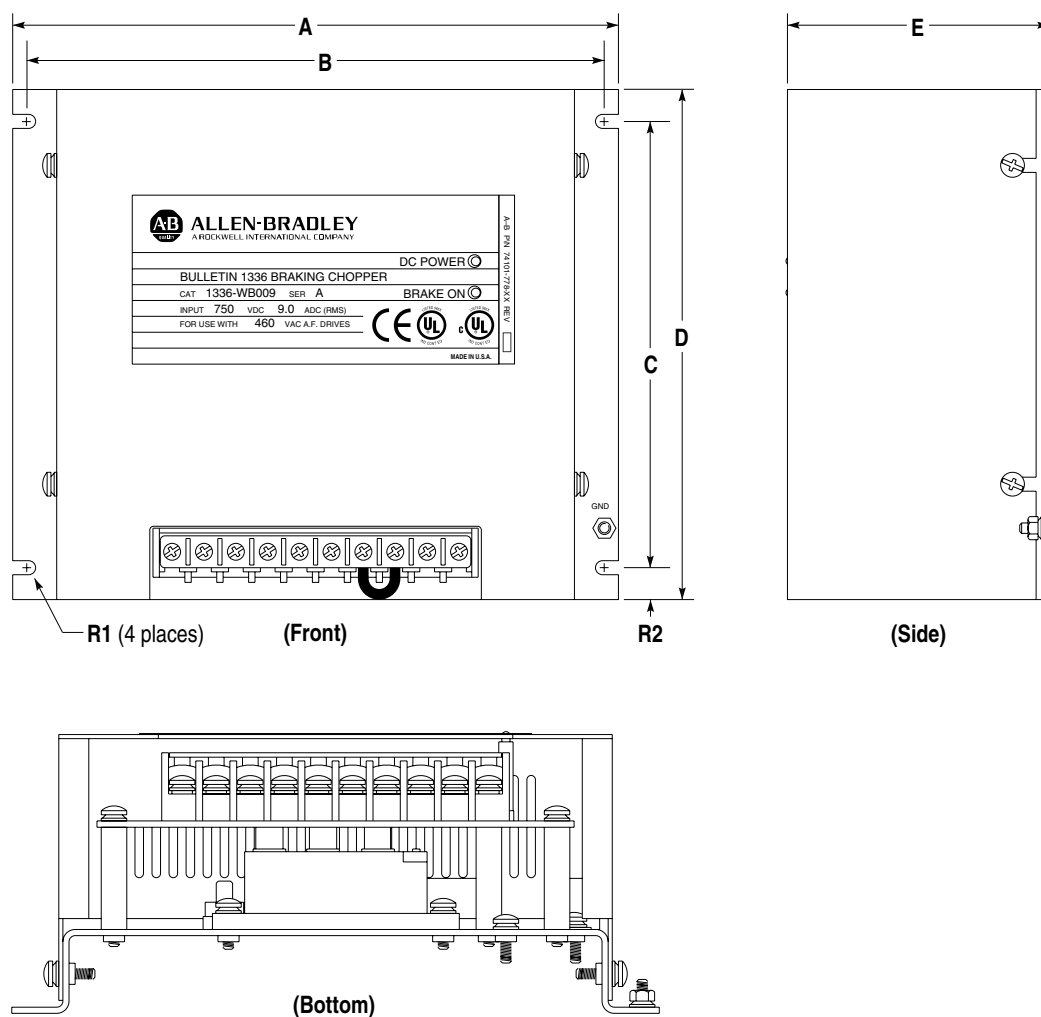
Ohms	Watts	Catalog	Watt Seconds	Manufacturer
5.1	59486	PF5F1R59K4	7375900	Powerohm
5.1	114750	PF5F1R114K4	25239300	Powerohm
5	22848	442-18A	1603773	IPC
5	30978	552-20A	1651395	IPC
5	34269	442-18	959801	IPC
5	46464	552-20	3891643	IPC
5	51028	445-18A	1733701	IPC
5	76534	445-18	3651418	IPC
4.8	2580	T4F8R2K58	185000	IPC
4.8	4590	T4F8R4K59	401000	IPC
4.8	5490	T4F8R5K49	169000	IPC
4.8	8880	T4F8R8K88	260000	IPC
4.8	10900	T4F8R10K9	359000	IPC
4.8	19200	T4F8R19K2	586000	IPC
4.8	25800	T4F8R25K8	984000	IPC
4.8	34600	T4F8R34K6	2310000	IPC
4.8	58200	T4F8R58K2	3696000	IPC
4.8	61000	T4F8R61K0	3916000	IPC
4.8	99300	T4F8R99K3	6159000	IPC
4.8	132000	T4F8R132K0	8077000	IPC
4.6	400	PF4F6R400W	16200	Powerohm
4.6	800	PF4F6R800W	37800	Powerohm
4.6	1200	PF4F6R1K20	53900	Powerohm
4.6	1600	PF4F6R1K60	125900	Powerohm
4.6	1630	PF4F6R1K62	61800	Powerohm
4.6	1801	PF4F6R1K80	71700	Powerohm
4.6	2433	PF4F6R2K43	133100	Powerohm
4.6	3120	PF4F6R3K12	168500	Powerohm
4.6	3869	PF4F6R3K86	383500	Powerohm
4.6	4710	PF4F6R4K71	537700	Powerohm
4.6	7360	PF4F6R7K36	1412200	Powerohm
4.6	9733	PF4F6R9K73	564200	Powerohm
4.6	12438	PF4F6R12K4	683600	Powerohm
4.6	15600	PF4F6R15K6	1497400	Powerohm
4.6	18841	PF4F6R18K8	2028400	Powerohm
4.6	23846	PF4F6R23K8	3073300	Powerohm
4.6	34817	PF4F6R34K8	3495100	Powerohm
4.6	66240	PF4F6R66K2	11386500	Powerohm
4.6	149040	PF4F6R149K9	37346900	Powerohm
4.5	6184	222-12A	152850	IPC
4.5	8266	222-12	239950	IPC
4.5	13810	225-12A	660558	IPC
4.5	20612	220-12A	1425576	IPC
4.5	20715	225-12	1425576	IPC
4.5	30918	220-12	1486256	IPC
4	28207	442-19A	1321116	IPC
4	42308	442-19	1386961	IPC
4	44057	552-21A	3441020	IPC
4	66084	552-21	1799627	IPC
3.9	32736	442-20A	2405659	IPC
3.9	49108	442-20	3246136	IPC
3.9	62996	445-19A	8013142	IPC
3.8	7227	222-13A	182571	IPC
3.8	9788	222-13	328491	IPC
3.8	16139	225-13A	430346	IPC
3.8	24089	220-13A	751149	IPC

Ohms	Watts	Catalog	Watt Seconds	Manufacturer
3.8	24212	225-13	1321116	IPC
3.8	36138	220-13	2672955	IPC
3.3	1200	PF3F3R1K20	61000	Powerohm
3.3	1876	PF3F3R1K87	105500	Powerohm
3.3	2230	PF3F3R2K23	124600	Powerohm
3.3	2775	PF3F3R2K77	317800	Powerohm
3.3	3379	PF3F3R3K37	380400	Powerohm
3.3	4299	PF3F3R4K29	556400	Powerohm
3.3	6982	PF3F3R6K98	376100	Powerohm
3.3	9251	PF3F3R9K25	512700	Powerohm
3.3	11101	PF3F3R11K1	1197900	Powerohm
3.3	13516	PF3F3R13K5	1530100	Powerohm
3.3	21489	PF3F3R21K4	3595800	Powerohm
3.3	24977	PF3F3R24K9	2541900	Powerohm
3.3	38491	PF3F3R38K4	5071000	Powerohm
3.3	47520	PF3F3R47K5	8390100	Powerohm
3.3	75001	PF3F3R75K0	15984900	Powerohm
3.3	106920	PF3F3R106K6	26362500	Powerohm
3.3	150001	PF3F3R150K0	41191400	Powerohm
3.3	214582	PF3F3R214K4	70836500	Powerohm
2.7	10500	222-14A	521631	IPC
2.7	15750	222-14	520110	IPC
2.7	23452	225-14A	1173670	IPC
2.7	35003	220-14A	2164091	IPC
2.7	35178	225-14	2187360	IPC
2.6	44505	442-21A	1126723	IPC
2.3	800	PF2F3R800W	63000	Powerohm
2.3	1200	PF2F3R1K20	56900	Powerohm
2.3	1600	PF2F3R1K60	165200	Powerohm
2.3	1664	PF2F3R1K66	112400	Powerohm
2.3	1934	PF2F3R1K93	211900	Powerohm
2.3	2356	PF2F3R2K35	253600	Powerohm
2.3	2980	PF2F3R2K98	365700	Powerohm
2.3	3680	PF2F3R3K68	723300	Powerohm
2.3	7737	PF2F3R7K73	767000	Powerohm
2.3	9420	PF2F3R9K42	1075400	Powerohm
2.3	14720	PF2F3R14K7	2824300	Powerohm
2.3	17408	PF2F3R17K4	1588700	Powerohm
2.3	27501	PF2F3R27K5	3688000	Powerohm
2.3	33273	PF2F3R33K2	5992900	Powerohm
2.3	55001	PF2F3R55K0	11778400	Powerohm
2.3	74520	PF2F3R74K5	18673500	Powerohm
2.2	13370	222-15A	316618	IPC
2.2	20053	222-15	1603773	IPC
2.2	29860	225-15A	1685270	IPC
2.2	44785	225-15	1724576	IPC
2.1	1200	PF2F1R1K20	84900	Powerohm
2.1	1420	PF2F1R1K42	83100	Powerohm
2.1	1767	PF2F1R1K76	168000	Powerohm
2.1	2151	PF2F1R2K15	253600	Powerohm
2.1	2722	PF2F1R2K72	365700	Powerohm
2.1	3361	PF2F1R3K36	599300	Powerohm
2.1	4443	PF2F1R4K44	266100	Powerohm
1.88	15350	222-16A	782447	IPC
1.88	23026	222-16	1570711	IPC
1.88	34281	225-16A	2138364	IPC
1.5	19884	222-17A	1308926	IPC

Chopper Module Characteristics

Drive Voltage (Volts AC)	Turn-On Voltage (Volts DC)	Catalog Number	Chopper Peak Transistor Current Rating (Amps)	Minimum Dynamic Brake Resistance Value (Ohms)
230	375	WA115	400	1.25
		WA070	200	2.3
		WA018	50	9.0
460	750	WB110	400	2.5
		WB035	100	9.0
		WB009	25	37.0
575	935	WC085	400	3.0
		WC035	75	15.5
		WC009	25	46.0

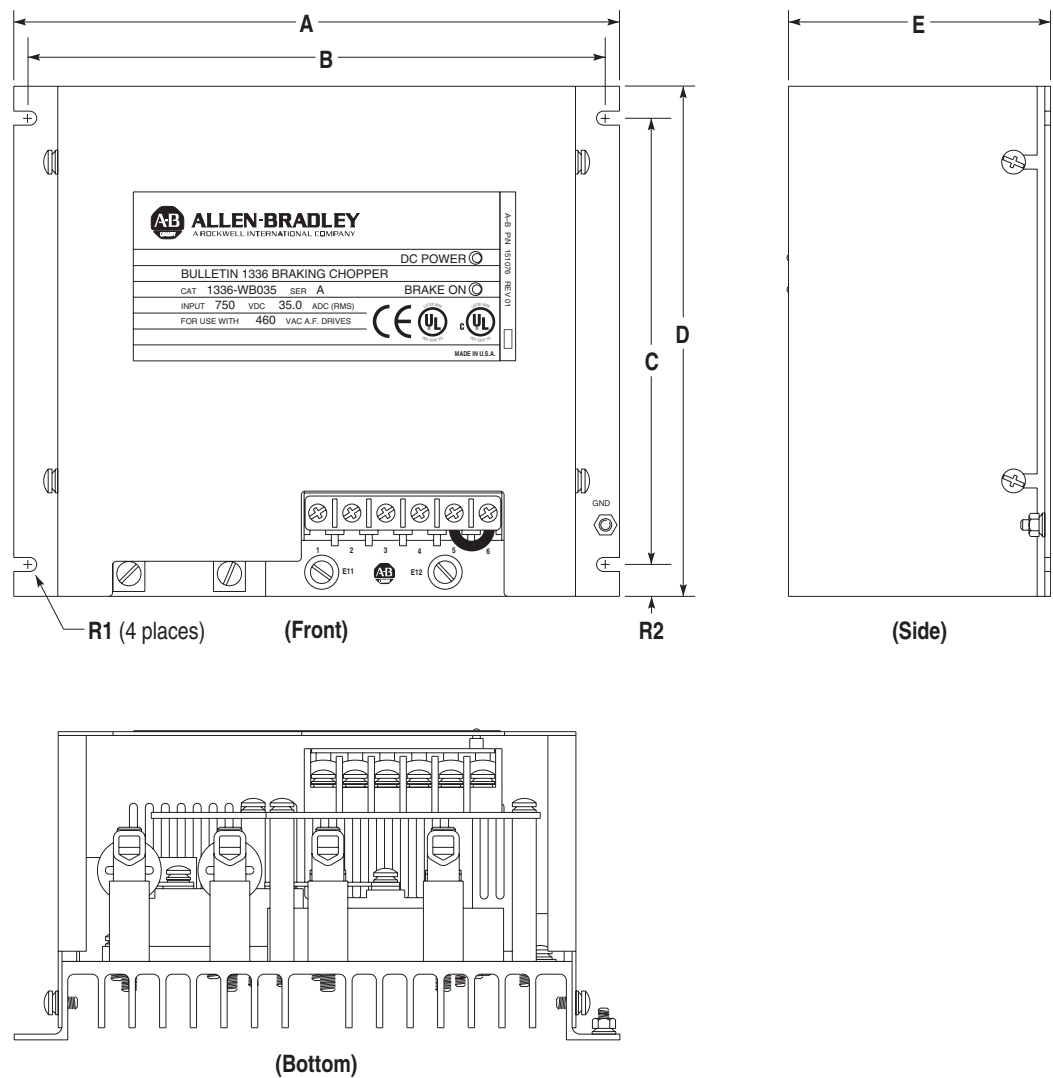
WA018, WB009 and WC009 Dimensions and Weights



Dimensions and Weights in Millimeters (Inches) and Kilograms (Pounds)

Chopper Module	A	B	C	D	E	R1 Dia.	R2	Weight
WA018	241.3	230.1	177.8	203.2	104.4	5.6	12.7	3.18
WB009	(9.50)	(9.06)	(7.00)	(8.00)	(4.11)	(0.22)	(0.50)	(7.0)
WC009								

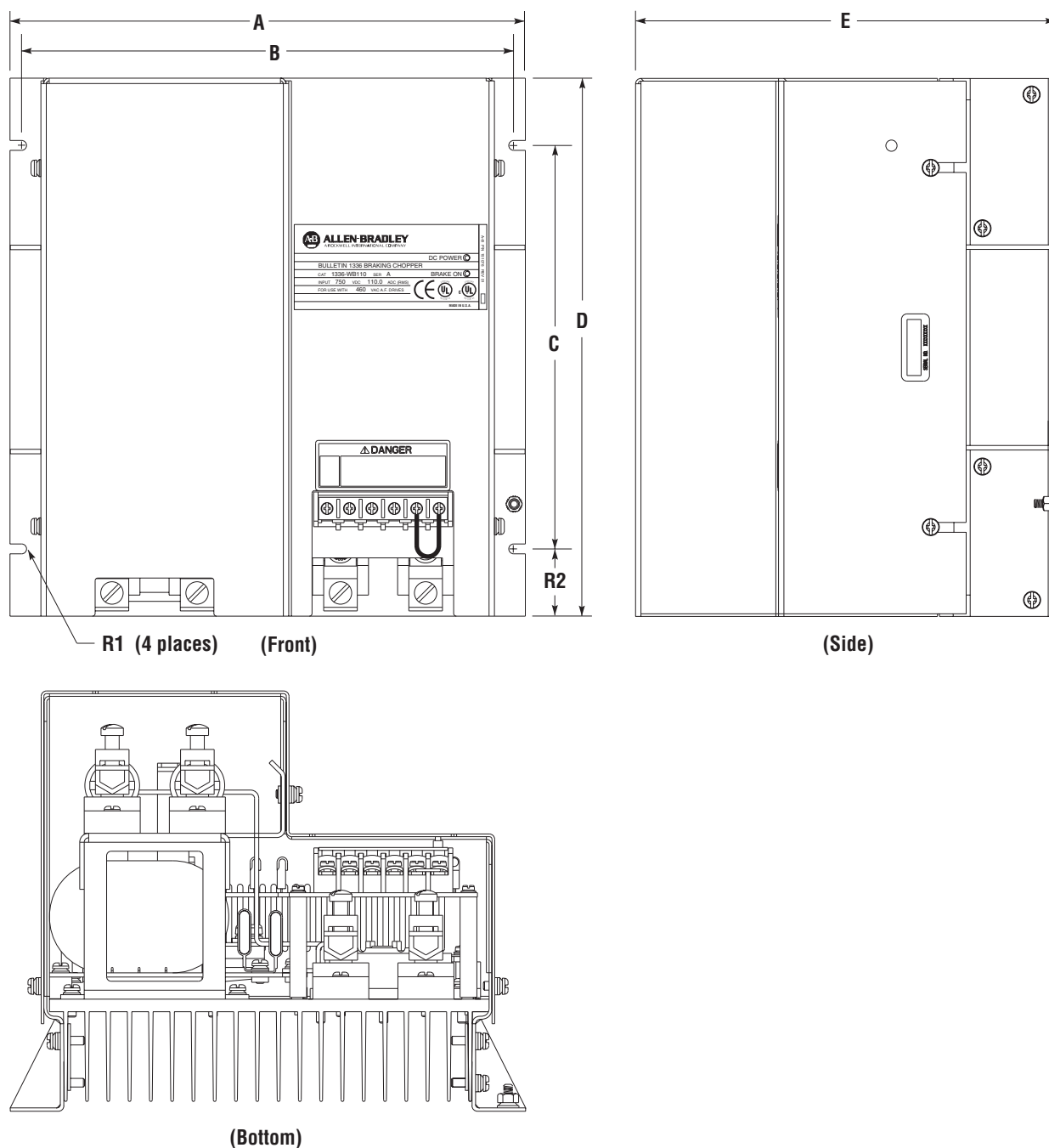
WA070, WB035 and WC035
Dimensions and Weights



Dimensions and Weights in Millimeters (Inches) and Kilograms (Pounds)

Chopper Module	A	B	C	D	E	R1 Dia.	R2	Weight
WA070	241.3	230.1	177.8	203.2	123.4	5.6	12.7	4.08
WB035	(9.50)	(9.06)	(7.00)	(8.00)	(4.86)	(0.22)	(0.50)	(9.0)
WC035								

WA115, WB110 and WC085 Dimensions and Weights



Dimensions and Weights in Millimeters (Inches) and Kilograms (Pounds)

Chopper Module	A	B	C	D	E	R1 Dia.	R2	Weight
WA115	290.6	279.4	228.6	304.8	239.8	5.6	38.1	11.34
WB110	(11.44)	(11.00)	(9.00)	(12.00)	(9.44)	(0.22)	(1.50)	(25.0)
WC085								

Specifications

Braking Torque & Duty Cycle	(Refer to pages 5-10)		
Input Power	DC power supplied from DC Bus.		
Brake Fault Contact	(1) N.C. contact, TTL compatible, closed when power is applied to the brake module, open when a brake fault or loss of power occurs.		
	UL/CSA Rating: 1.0 Amps, 125VAC. 1.0 Amps, 110VAC. 2.0 Amps, 30VDC.		
	CE Certification: Low Voltage EN 60204-1. PREN 50178.		
	Initial Contact Resistance: 100mOhms maximum.		
Operating Temperature	Chopper: -10°C to 40°C (14°F to 104°F). Resistors: -10°C to 50°C (14°F to 122°F).		
Storage Temperature	Chopper: -40°C to 70°C (-40°F to 158°F). Resistors: -40°C to 70°C (-40°F to 158°F).		
Humidity	5% to 95% non-condensing.		
Atmosphere	Noncorrosive/nonhazardous dust, vapor or gas.		
Altitude Derating	1,000 meters (3,300 feet) maximum without derating.		
Enclosure Type	IP00 (Open)		
Watts Dissipated ¹	WA018, WB009, WC009:75W at 100% Duty Cycle WA070, WB035, WC035:115W at 100% Duty Cycle WA115, WB110, WC085:190W at 100% Duty Cycle		
Minimum Brake Resistance	WA018 = 9.0 Ohms	WB009 = 37.0 Ohms	WC009 = 46.0 Ohms
	WA070 = 2.5 Ohms	WB035 = 9.0 Ohms	WC035 = 15.5 Ohms
	WA115 = 1.25 Ohms	WB110 = 2.5 Ohms	WC085 = 3.0 Ohms

¹ Watts Dissipated at 100% (Continuous Duty Cycle) are approximately equal to the average watts dissipated at 20 and 50% Duty Cycles.

Installation Requirements



ATTENTION: Electric Shock can cause injury or death. Remove all power before working on this product.

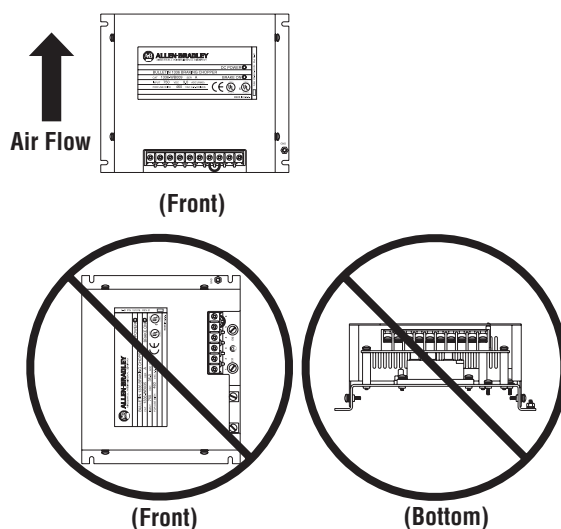
For all chopper module ratings, DC brake power is supplied from the drive DC Bus.

Hazards of electrical shock exist if accidental contact is made with parts carrying bus voltage. A DC power indicator on the brake enclosures provides visual indication that bus voltage is present. Before proceeding with any installation or troubleshooting activity, allow at least one minute after input power has been removed for the bus circuit to discharge. Bus voltage should be verified by using a voltmeter to measure the voltage between the +DC and -DC terminals on the drive power terminal block. Do not attempt any servicing until the DC power indicating light has extinguished and bus voltage has been verified to be zero volts.

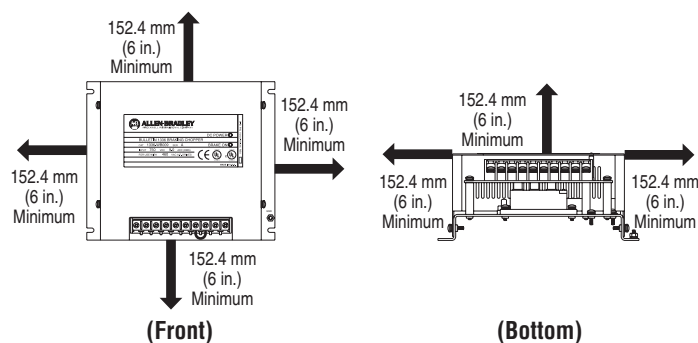
Mounting Requirements

IMPORTANT: The National Electrical Code (NEC) and local regulations govern the installation and wiring of the brake chopper modules, dynamic braking resistors and enclosure selection. DC power wiring, AC power wiring, control wiring and conduit must be chosen, sized and installed in accordance with these codes and the information supplied on the following pages.

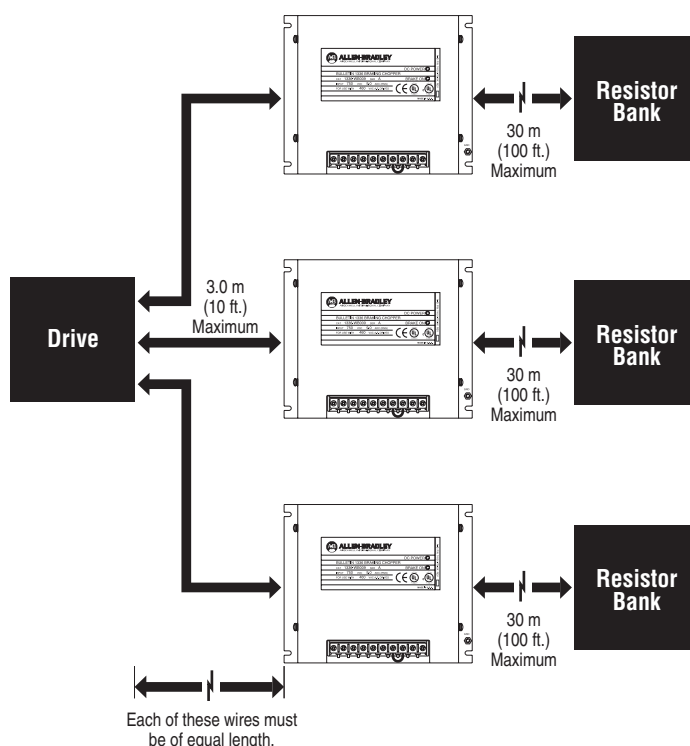
Brake chopper modules must only be installed in the vertical position. Select an enclosure and a location using the guidelines below and on the following page.



1. Allow a minimum clearance of 152.4 mm (6 in.) Between brake modules inside an enclosure and all other equipment including the drive. All brake resistor banks should be mounted external to the enclosure on a non combustible surface.



2. If more than one module is required, all modules must be mounted within 3.0 m (10 ft.) of the drive. The wires used to connect each module to the drive must be the same length. Resistors must be located within 30 m (100 ft.) of the chopper module. The minimum distance between each resistor bank and all other enclosures or equipment is application dependent and must be determined by the user.



Setup



ATTENTION: Each brake chopper module contains a thermostat to guard against overheating and component damage.

If the duty cycle, torque setting and/or ambient temperature exceeds the specifications listed in this publication, the thermostat is designed to trip and disable the brake modules until components cool to rated temperature. During the cooling period, only 10% braking torque will be available to the motor.

If reduced braking torque represents a potential hazard to personnel, auxiliary stopping methods must be considered in the machine and/or control circuit design.

1336 and 1336VT Parameter Settings

Parameter 11 — Decel Frequency Hold — must be set to OFF when dynamic braking is installed. Refer to your 1336 or 1336VT Programming Manual for programming procedures and record the changes for future reference.

1336IMPACT Parameter Settings

When dynamic braking is installed:

- Parameter 76 [Regen Power Lim] typically should be set to its factory default of “-200.0%”. A lower Regen Power Lim may be required to protect the load during decel.
- Set Bit 10 of Parameter 13 [Bus Options].

Refer to your 1336IMPACT User Manual for programming procedures and record the changes for future reference.

1336FORCE Parameter Settings

When dynamic braking is installed:

- A lower Regen Power Lim may be required to protect the load during decel. Parameter 178 [Regen Power Lim] typically should be set to the required negative % of torque.
- Clear Bit 11 of Parameter 88 [VP Flt/Warn Cfg].

Refer to your 1336FORCE User Manual for programming procedures and record the changes for future reference.

1336PLUS and 1336PLUSII Parameter Settings

When dynamic braking is installed:

- Parameter 11 [Bus Limit En] must be set to “Disabled”.
- Braking for deceleration requires that the drive be programmed for “Ramp-to-Stop”. Braking for overhauling loads may or may not be stop mode specific. Program Parameters 10 and 52 per the application.

Refer to your 1336PLUS User Manual for programming procedures and record the changes for future reference.

Brake Fault Contact Monitoring

For all brake module ratings a fault contact has been provided to provide a remote output signal. Should a brake fuse fail or the brake thermostat trip, the brake fault contact will open. Interconnection wiring for remote brake monitoring is provided in the Wiring Schemes section.

Brake Fuses

All brake modules are internally fused to protect brake components. When replacing brake fuses, use only the type and size specified below.

Dynamic Brake	Fuse	Fuse Type	Rating
WA018	F1 & F2	Ferraz Shawmut	A60Q or Equivalent
WB009	F1 & F2		A60Q or Equivalent
WC009	F1 & F2		A60Q or Equivalent
WA070	F1 & F2	Ferraz Shawmut	A70QS or Equivalent
WB035	F1 & F2		A70QS or Equivalent
WC035	F1 & F2		A70QS or Equivalent
WA115	F1 & F2	Ferraz Shawmut	A70QS or Equivalent
WB110	F1 & F2		A70QS or Equivalent
WC085	F1 & F2		A70QS or Equivalent

Brake Module Jumper Settings

For the **Mounting Requirements** shown previously as well as the **Wiring Schemes**, there can be only one master brake module to control dynamic braking. When multiple brake modules are used, only one brake module can serve as the master brake to control the remaining slave brake modules.

Slave/Master Jumper Set to Master

BRAKE MODE MASTER SLAVE	BRAKE MODE SLAVE MASTER	BRAKE MODE SLAVE MASTER
W1  1 (2)(3)	W1  (3)(2) 1	W1  (3)(2)(1)
Cat. No. WA018 WB009 WC009	Cat. No. WA070 WB035 WC035	Cat. No. WA115 WB110 WC085

Master Brake Module Jumper Settings

For the master brake module, leave slave/master jumper W1 factory set to master (jumper positions 1 & 2).

Slave/Master Jumper Set to Slave

BRAKE MODE MASTER SLAVE	BRAKE MODE SLAVE MASTER	BRAKE MODE SLAVE MASTER
W1  1 (2)(3)	W1  (3)(2) 1	W1  (3)(2)(1)
Cat. No. WA018 WB009 WC009	Cat. No. WA070 WB035 WC035	Cat. No. WA115 WB110 WC085

Slave Brake Module Jumper Settings

For each slave module, reset jumper W1 to slave (jumper positions 2 & 3).

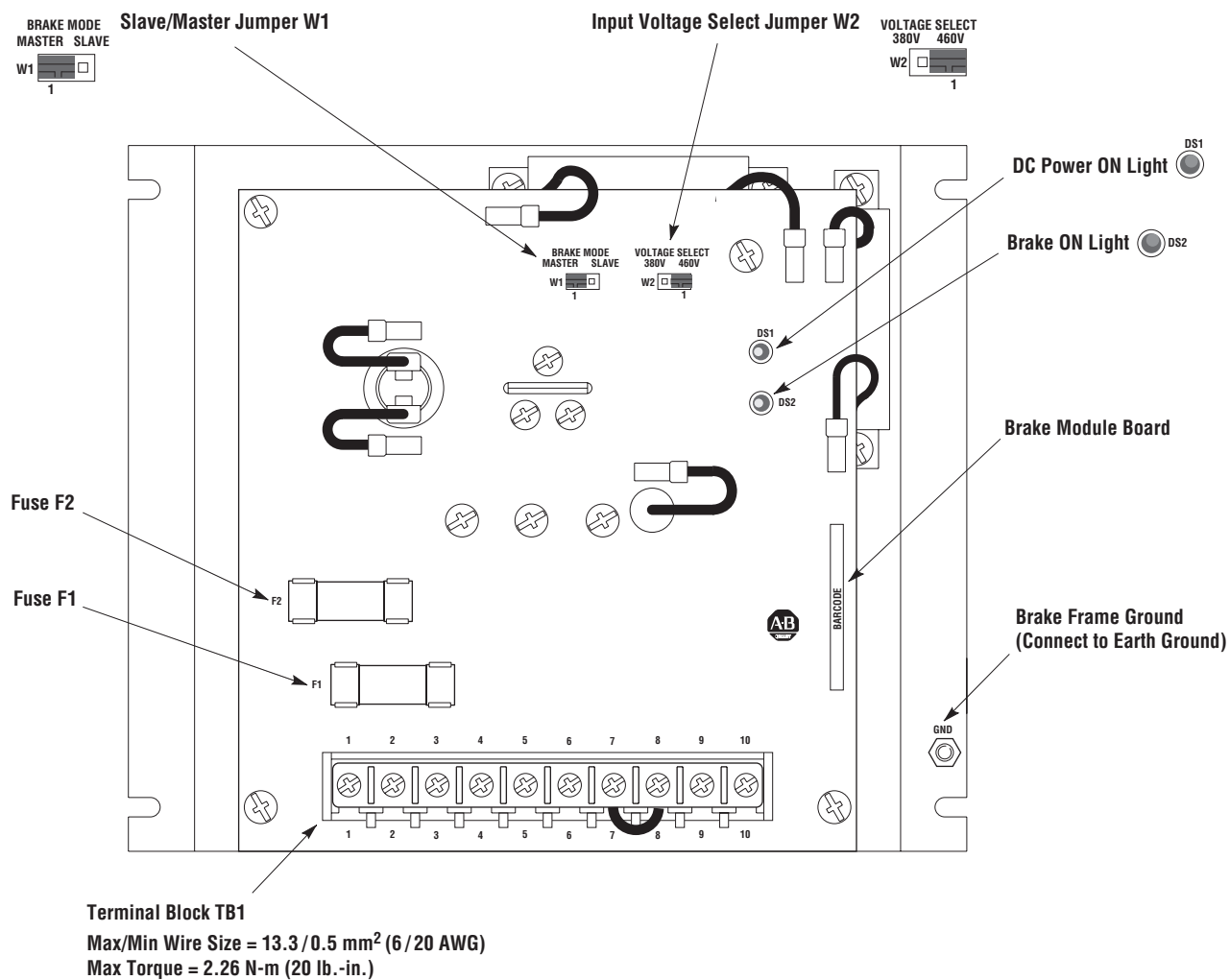
Input Voltage Jumper Set to 460V

VOLTAGE SELECT 380V 460V	VOLT SELECT 380V 460V
W2  (3)(2) 1	W2  (3)(2)(1)
Cat. No. WB009	Cat. No. WB035 WB110

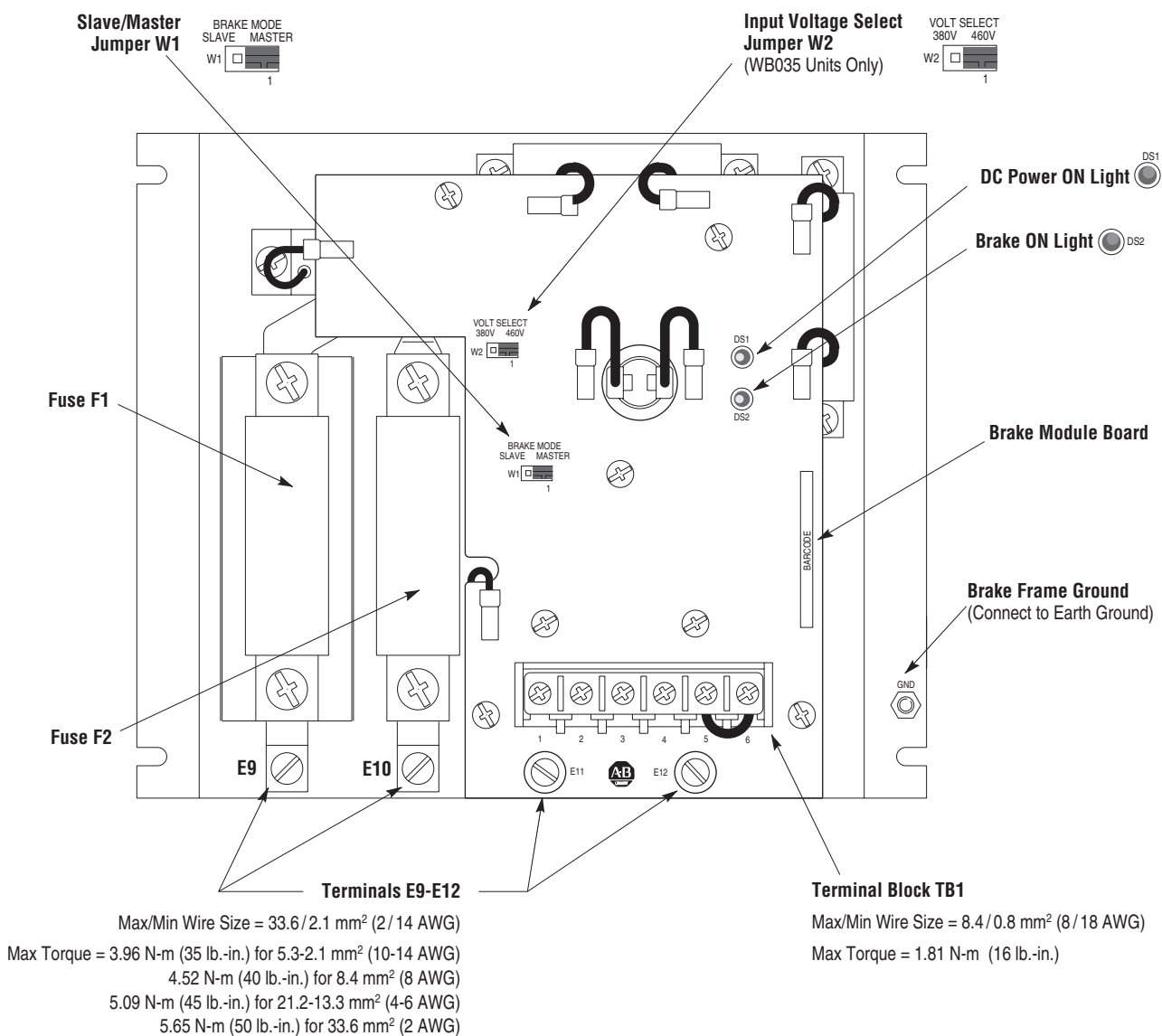
Input Voltage Jumper Settings

Set jumper W2 on 460V models to correspond to the nominal drive input voltage. Setting the jumper between positions 1 & 2 will select an input voltage of 415/460 volts. Setting the jumper between positions 2 & 3 will select an input voltage of 380 volts. **Only models WB009, WB035 & WB110 have input voltage jumpers.**

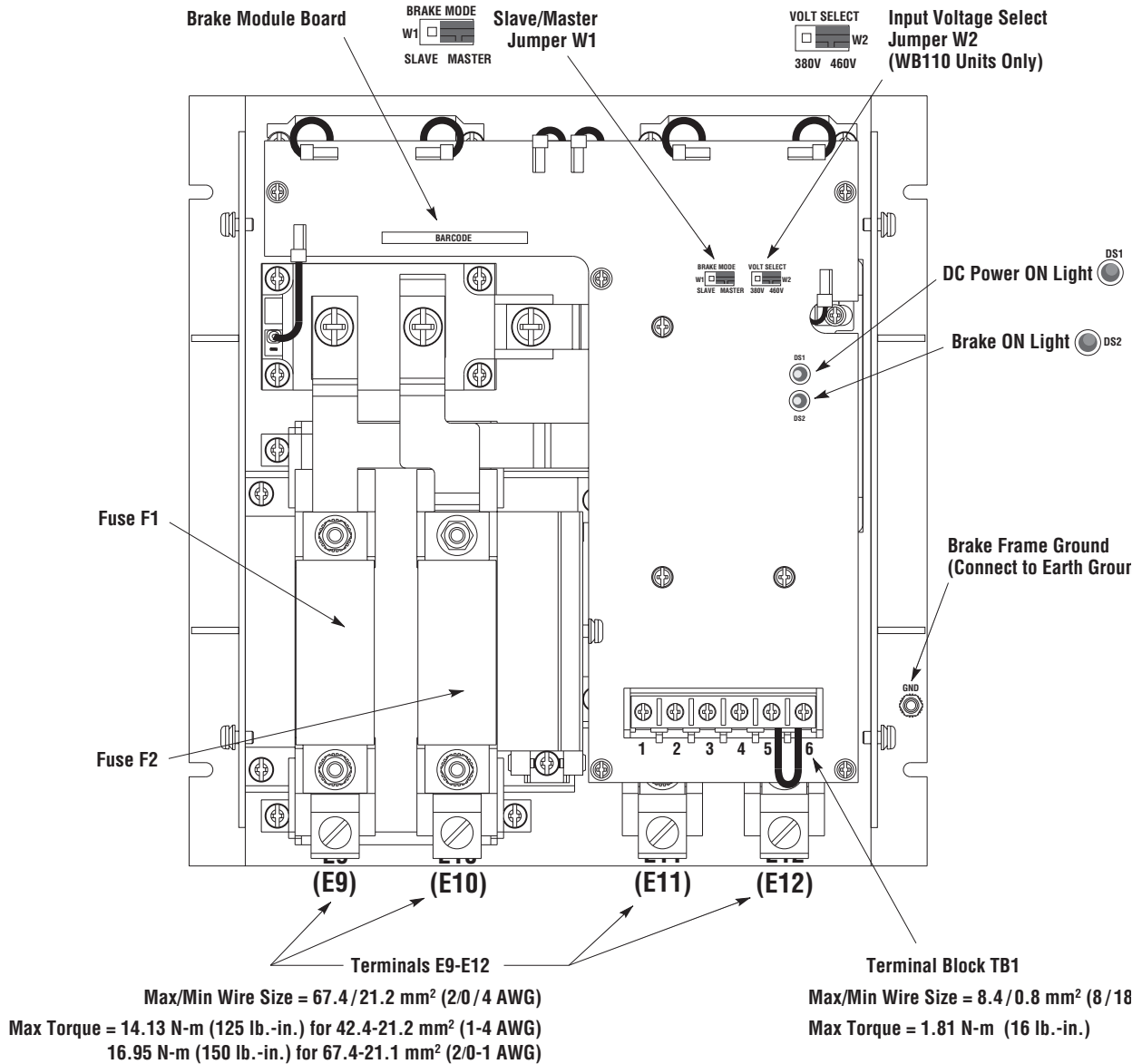
WA018, WB009 and WC009 Terminal Block, Fuse and Jumper Locations



WA070, WB035 and WC035 Terminal Block, Fuse and Jumper Locations



WA115, WB110 and WC085 Terminal Block, Fuse and Jumper Locations



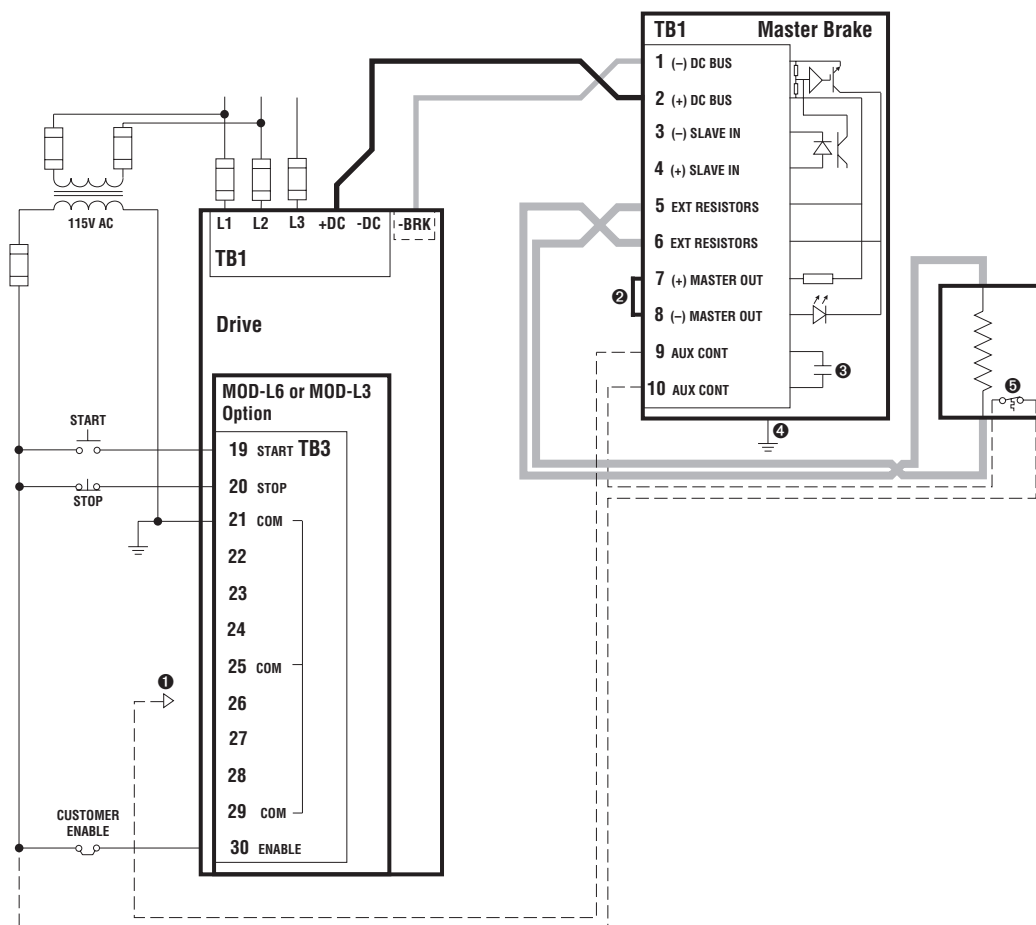
WA018, WB009 and WC009 Single Brake Wiring Scheme

For Drive Catalog
Numbers:

1336F –
BRF75
BRF100
1336S –
BRF75
BRF100



ATTENTION:
Damage to drives
can result from
improper wiring.
Read drive
nameplate to
confirm catalog
number and rating
code to determine
correct wiring
diagram.



— -DC Brake Power Wiring

— +DC Brake Power Wiring

— Brake Resistor Wiring

All Brake Power and Brake Resistor
Wiring must be twisted wire run in conduit
separate from Control Wiring. Size wire
according to NEC and local guidelines.

— Control Wiring

All Control Wiring must be twisted wire run in
conduit separate from DC Brake Power Wiring.
Interconnection Control Wiring between the brake
terminals must be twisted pair, 1 mm² (18 AWG)
minimum.

— Typical Brake Fault Contact Wiring

① Connect to AUX at TB3 — Terminal 24 for L6 Option
— Terminal 28 for L3 Option.

② MASTER OUT terminals are factory jumpered and must
remain jumpered for single brake applications. For
multiple brake applications, remove the jumpers in all
but the last enclosure.

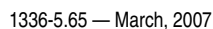
③ Contact is shown in a de-energized state. Contact is closed
when power is applied and relay is energized. Loss of power or
a brake malfunction will open contact.

④ Connect the brake frame to earth ground. Refer to the connected drive's User Manual for grounding instructions.

⑤ Optional overtemperature switch.

**For Drive Catalog
Numbers:**
1336F –
 BRF75
 BRF100
1336S –
 BRF75
 BRF100

ATTENTION: Damage to drives can result from improper wiring. Read drive nameplate to confirm catalog number and rating code to determine correct wiring diagram.

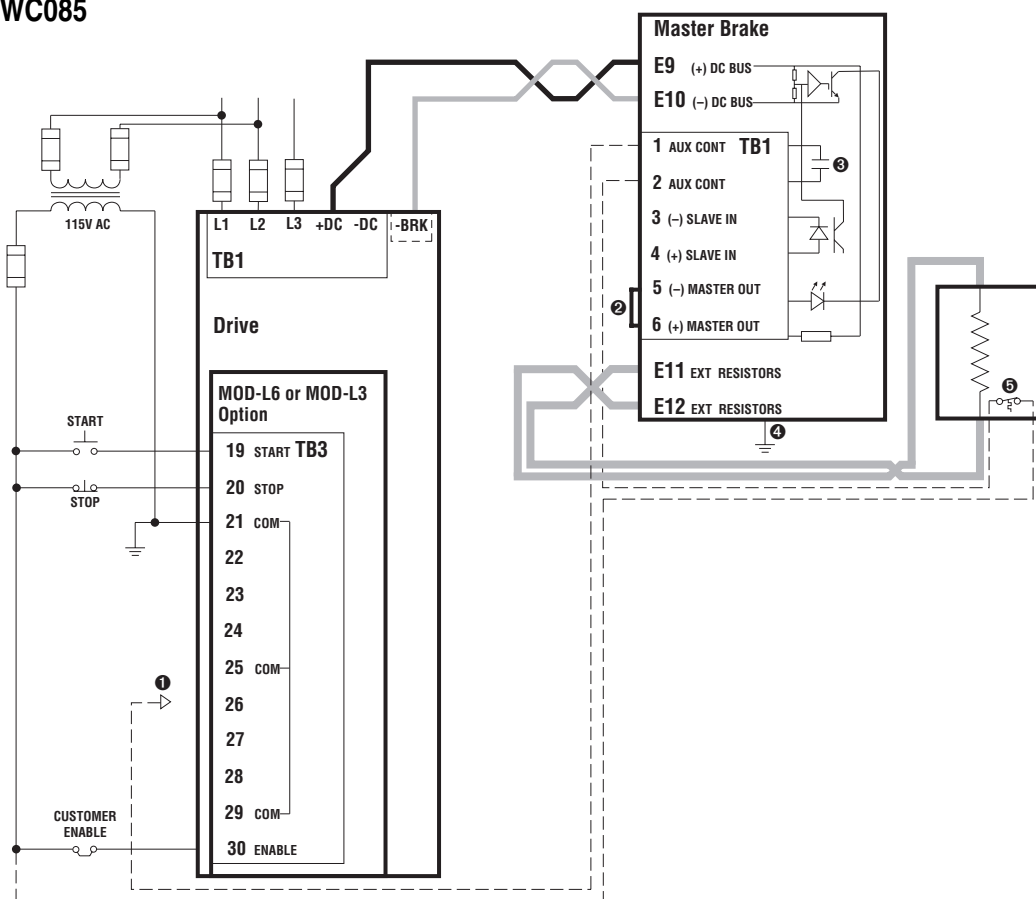


WA070, WB035 and WC035
WA115, WB110 and WC085
Single Brake
Wiring Scheme

For Drive Catalog
Numbers:
1336F –
BRF150
BRF200



ATTENTION:
 Damage to drives can result from improper wiring. Read drive nameplate to confirm catalog number and rating code to determine correct wiring diagram.



— -DC Brake Power Wiring

— +DC Brake Power Wiring

--- Brake Resistor Wiring

All Brake Power and Brake Resistor Wiring must be twisted wire run in conduit separate from Control Wiring. Size wire according to NEC and local guidelines.

==== Control Wiring

All Control Wiring must be twisted wire run in conduit separate from DC Brake Power Wiring. Interconnection Control Wiring between the brake terminals must be twisted pair, 1 mm² (18 AWG) minimum.

--- Typical Brake Fault Contact Wiring

① Connect to AUX at TB3 — Terminal 24 for L6 Option — Terminal 28 for L3 Option.

② MASTER OUT terminals are factory jumpered and must remain jumpered for single brake applications. For multiple brake applications, remove the jumpers in all but the last enclosure.

③ Contact is shown in a de-energized state. Contact is closed when power is applied and relay is energized. Loss of power or a brake malfunction will open contact.

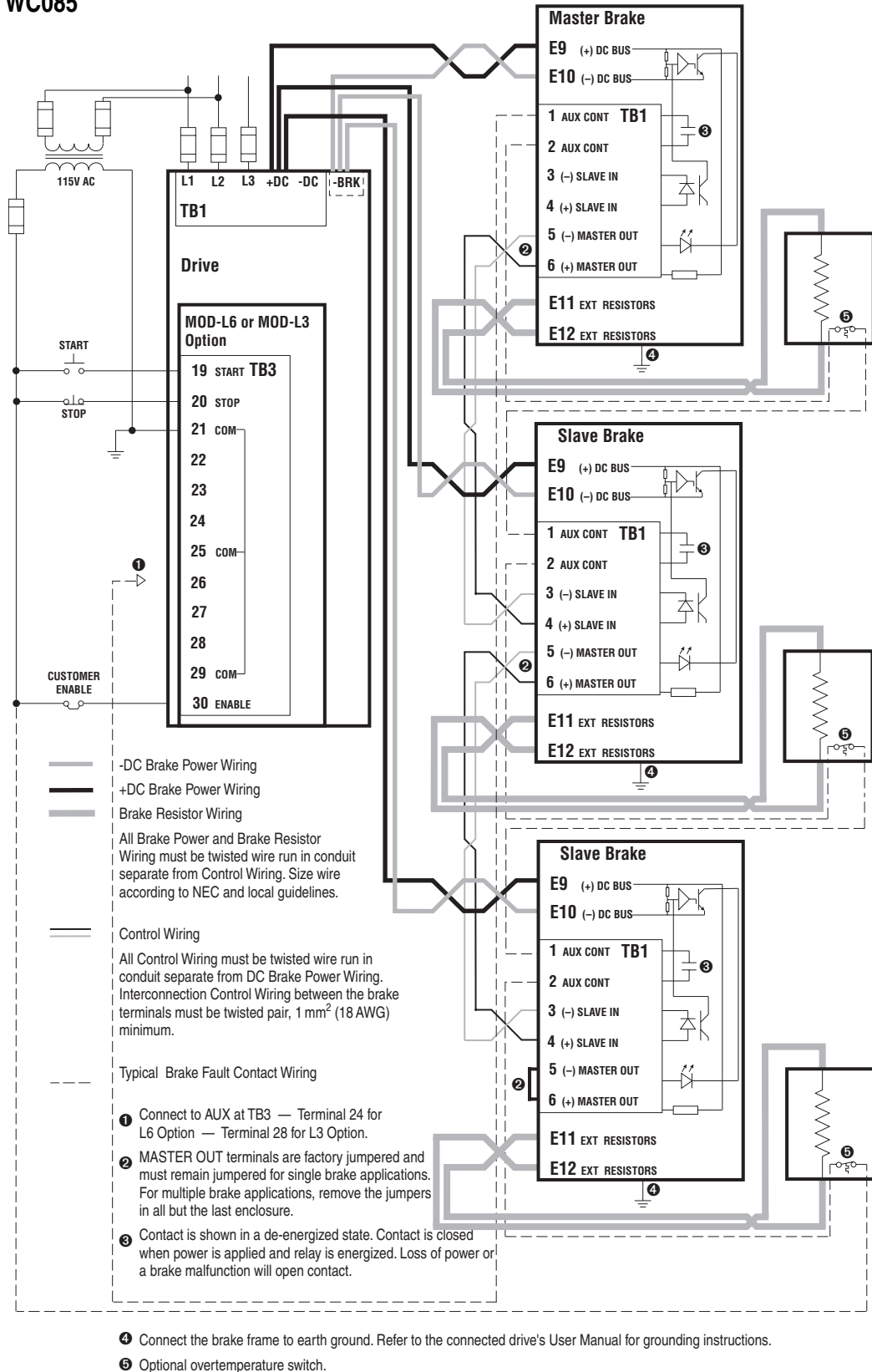
④ Connect the brake frame to earth ground. Refer to the connected drive's User Manual for grounding instructions.

⑤ Optional overtemperature switch.

WA070, WB035 and WC035 WA115, WB110 and WC085 Multiple Brake Wiring Scheme

For Drive Catalog
Numbers:
1336F –
BRF150
BRF200

ATTENTION:
Damage to drives can result from improper wiring. Read drive nameplate to confirm catalog number and rating code to determine correct wiring diagram.

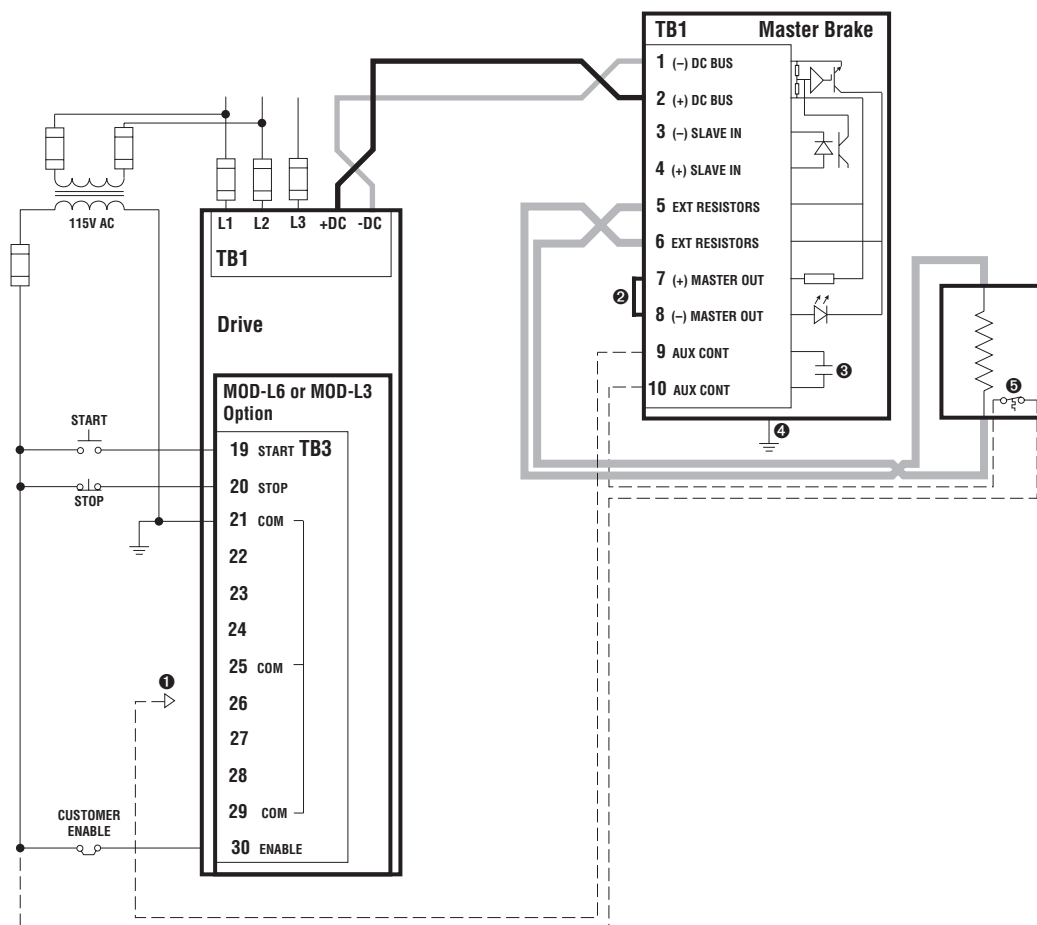


WA018, WB009 and WC009 Single Brake Wiring Scheme

For Drive Catalog
Numbers:

1336
1336VT
1336S
1336F
1336T
1336E

⚠ ATTENTION:
Damage to drives can result from improper wiring. Read drive nameplate to confirm catalog number and rating code to determine correct wiring diagram.



— -DC Brake Power Wiring

— +DC Brake Power Wiring

— Brake Resistor Wiring

All Brake Power and Brake Resistor Wiring must be twisted wire run in conduit separate from Control Wiring. Size wire according to NEC and local guidelines.

— Control Wiring

All Control Wiring must be twisted wire run in conduit separate from DC Brake Power Wiring. Interconnection Control Wiring between the brake terminals must be twisted pair, 1 mm² (18 AWG) minimum.

- - - Typical Brake Fault Contact Wiring

① Connect to AUX at TB3 — Terminal 24 for L6 Option
— Terminal 28 for L3 Option.

② MASTER OUT terminals are factory jumpered and must remain jumpered for single brake applications. For multiple brake applications, remove the jumpers in all but the last enclosure.

③ Contact is shown in a de-energized state. Contact is closed when power is applied and relay is energized. Loss of power or a brake malfunction will open contact.

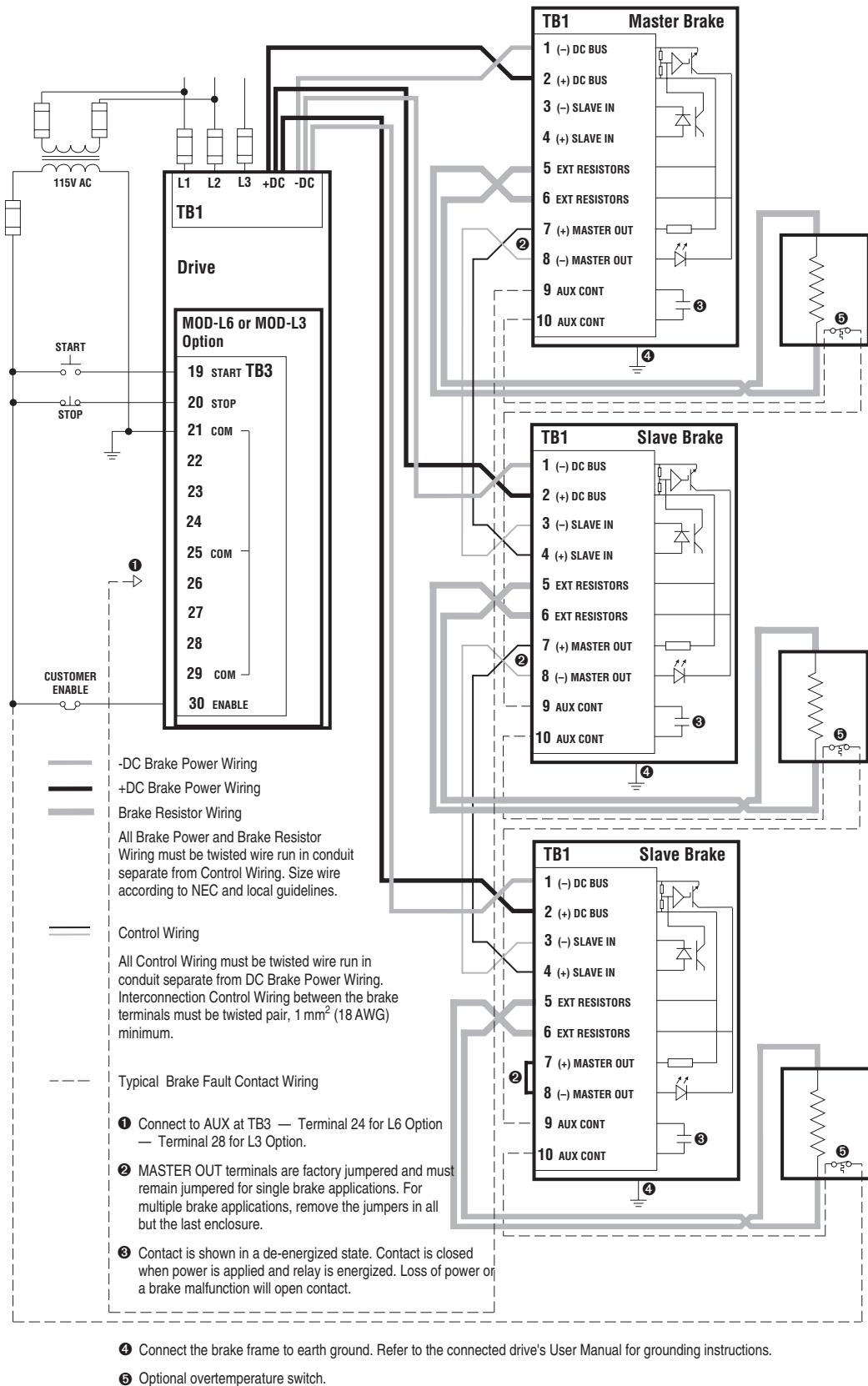
④ Connect the brake frame to earth ground. Refer to the connected drive's User Manual for grounding instructions.

⑤ Optional overtemperature switch.

WA018, WB009 and WC009 Multiple Brake Wiring Scheme

For Drive Catalog
Numbers:
1336
1336VT
1336S
1336F
1336T
1336E

⚠ ATTENTION:
Damage to drives
can result from
improper wiring.
Read drive
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correct wiring
diagram.

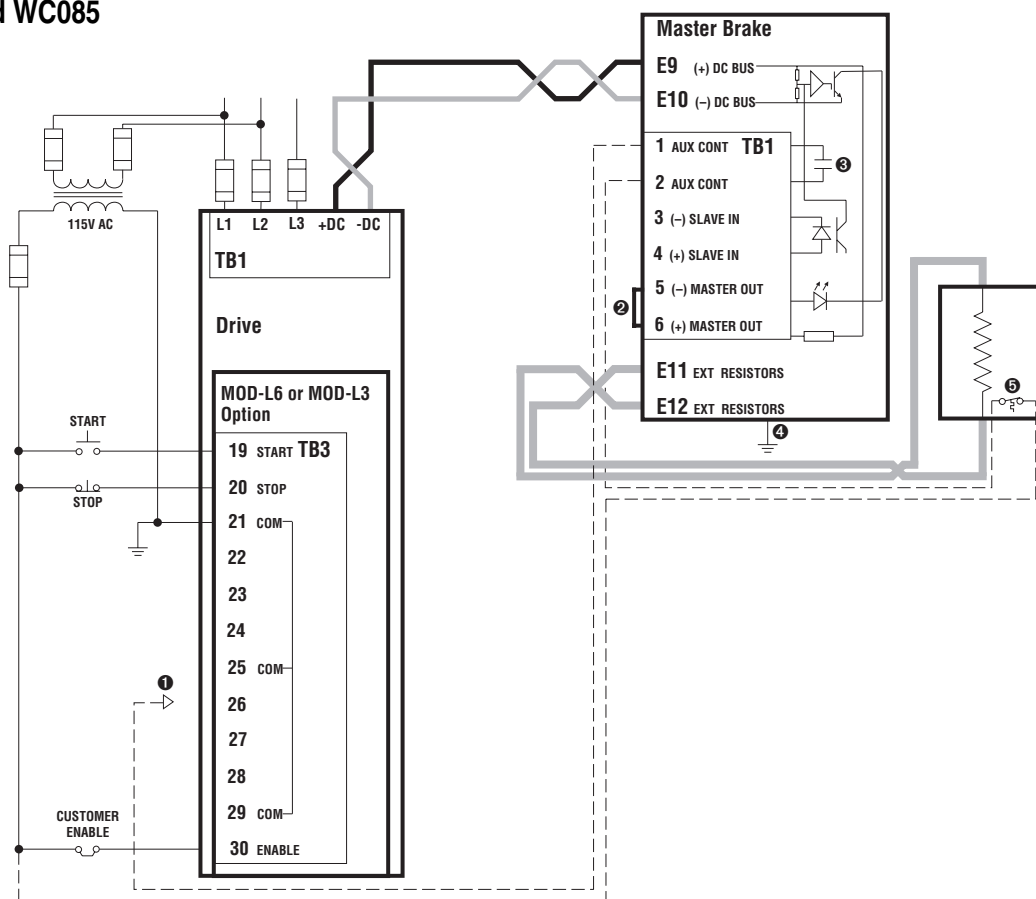


WA070, WB035 and WC035
WA115, WB110 and WC085
Single Brake
Wiring Scheme

For Drive Catalog
Numbers:

1336
1336VT
1336S
1336F
1336T
1336E

⚠ ATTENTION:
 Damage to drives
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 improper wiring.
 Read drive
 nameplate to
 confirm catalog
 number and rating
 code to determine
 correct wiring
 diagram.



- -DC Brake Power Wiring
- +DC Brake Power Wiring
- Brake Resistor Wiring

All Brake Power and Brake Resistor
 Wiring must be twisted wire run in conduit
 separate from Control Wiring. Size wire
 according to NEC and local guidelines.

- Control Wiring
- All Control Wiring must be twisted wire run in
 conduit separate from DC Brake Power Wiring.
 Interconnection Control Wiring between the brake
 terminals must be twisted pair, 1 mm² (18 AWG)
 minimum.

- - - Typical Brake Fault Contact Wiring

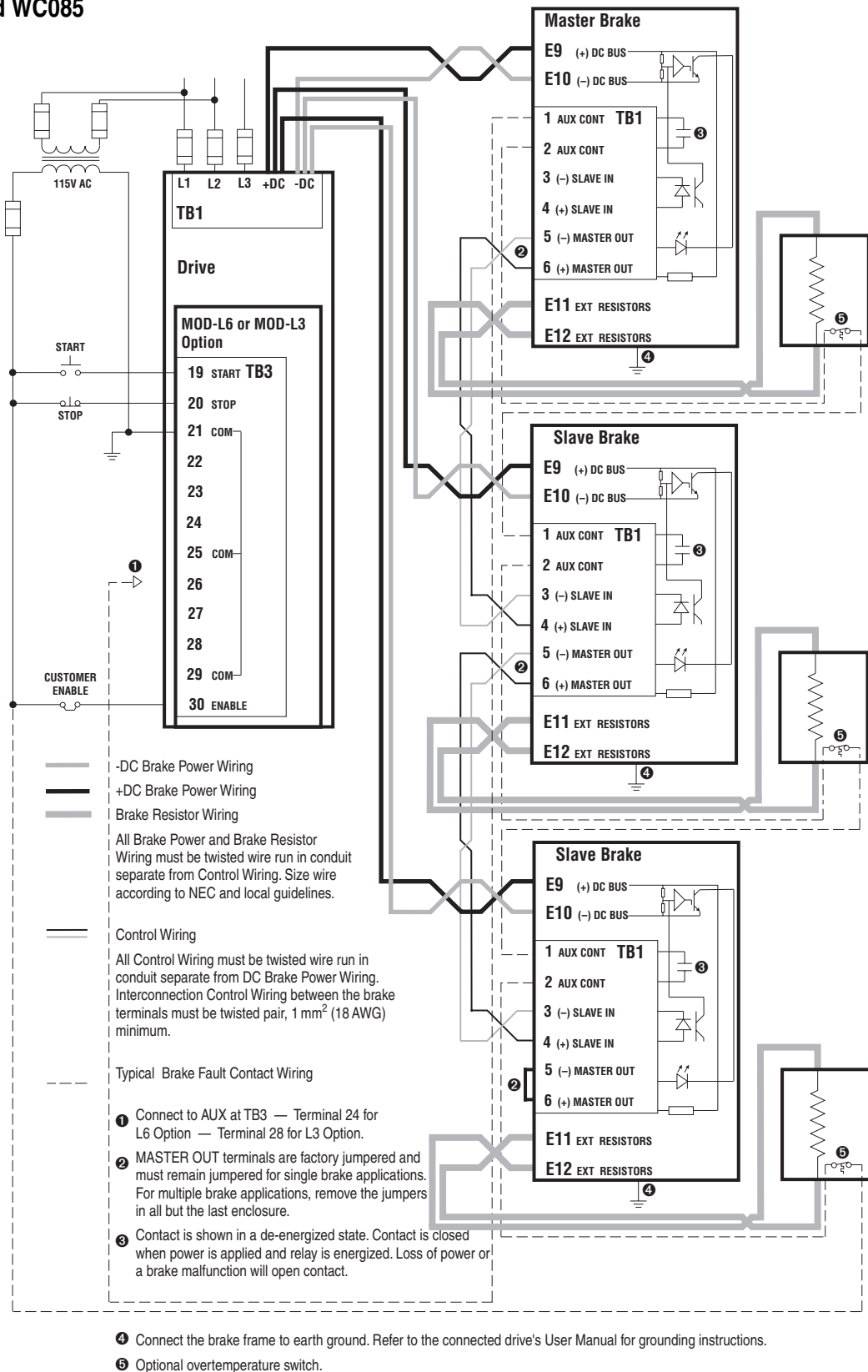
- ① Connect to AUX at TB3 — Terminal 24 for
 L6 Option — Terminal 28 for L3 Option.
- ② MASTER OUT terminals are factory jumpered and
 must remain jumpered for single brake applications.
 For multiple brake applications, remove the jumpers
 in all but the last enclosure.
- ③ Contact is shown in a de-energized state. Contact is closed
 when power is applied and relay is energized. Loss of power or
 a brake malfunction will open contact.
- ④ Connect the brake frame to earth ground. Refer to the connected drive's User Manual for grounding instructions.
- ⑤ Optional overtemperature switch.

WA070, WB035 and WC035 WA115, WB110 and WC085 Multiple Brake Wiring Scheme

For Drive Catalog
Numbers:

1336
1336VT
1336S
1336F
1336T
1336E

⚠ ATTENTION:
Damage to drives
can result from
improper wiring.
Read drive
nameplate to
confirm catalog
number and rating
code to
determine
correct wiring



NOTES

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